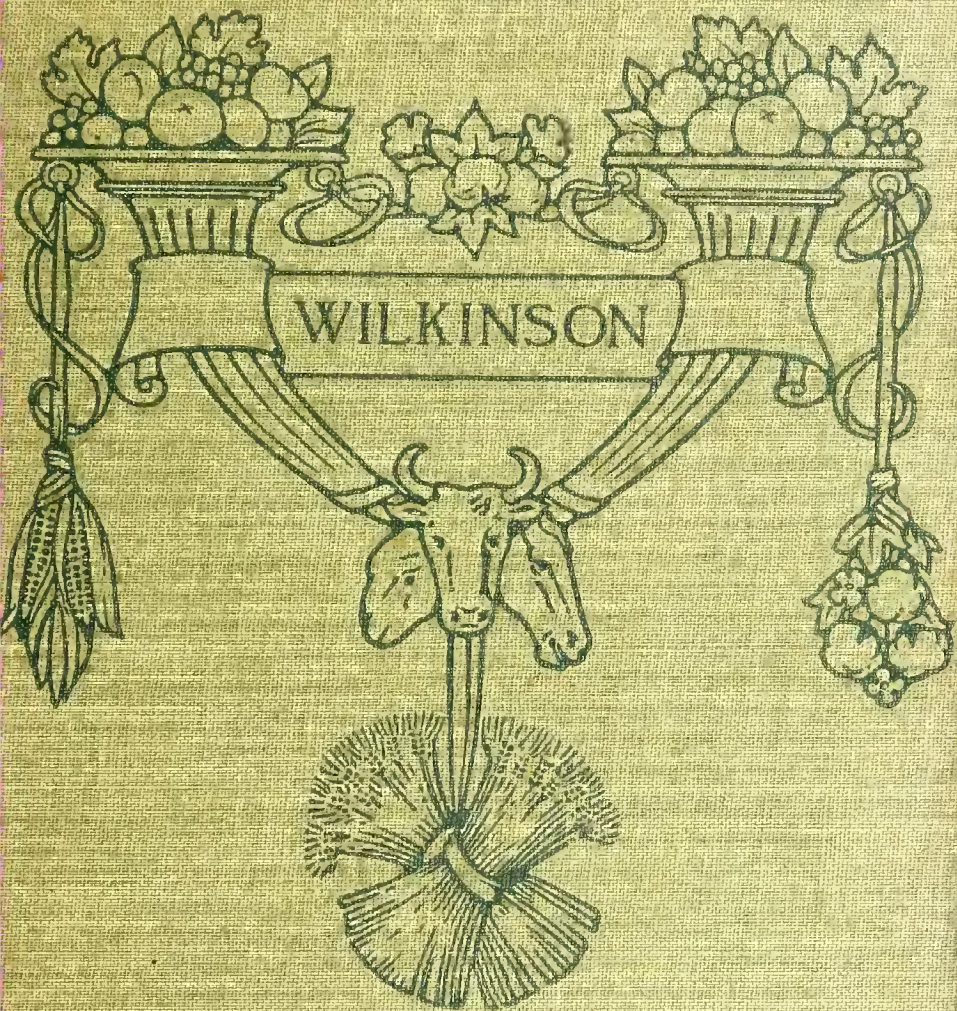


PRACTICAL AGRICULTURE



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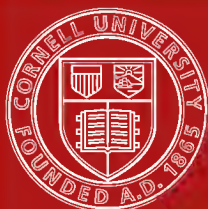
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PRACTICAL AGRICULTURE

A BRIEF TREATISE

ON

AGRICULTURE, HORTICULTURE, FORESTRY,
STOCK FEEDING, ANIMAL HUSBANDRY,
AND ROAD BUILDING

BY

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NEW YORK :: CINCINNATI :: CHICAGO
AMERICAN BOOK COMPANY

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PREFACE

ALTHOUGH the advanced work in agricultural education has long been provided for in both Europe and America by Colleges and Chairs in some of the Universities, it is only of recent years that the public has awakened to the pressing need of practical agricultural instruction in our public schools.

The demand for this work is growing stronger and stronger all the time, and wherever the subject of agriculture has been taught in the public schools the results have been highly satisfactory. President Roosevelt, through the National Commission on Country Life, aroused a great deal of interest in country life and country social conditions which is finding expression in many ways. Our whole nation is beginning to realize the need of better rural schools and more practical instruction.

The Committee on Industrial Education for the Country Communities appointed by the National Educational Association in 1905 struck the keynote when it said: "The country schools, which train nearly one half of the school population of this country so far as school training goes, should definitely recognize the fact that the major portion of those being trained will continue to live upon the farm; and that there should be specific, definite technical training fitting them for the activities of farm life. Such schools will not make farmers nor housekeepers, but they will interest the boys and girls in farming and housekeeping and the problems connected with these two important vocations."

Likewise it is no less important that pupils in our city schools should receive some instruction in agriculture so that they may have a proper conception of the country and the opportunities they might enjoy there which would be denied them in the city.

The tendency of our ambitious young people to collect in the cities and large centers of population is fraught with the gravest danger. In the country there are health, wealth, and happiness,

and our young people in the cities must be made to realize this fact. The solid and substantial wealth of our nation comes from the country and not from the city, but this hard-earned wealth produced on the farms is being nearly all diverted to the improvement of cities and city institutions, instead of being used for the improvement of the country and its institutions. The time is now at hand when there must be an organized and determined effort to correct this condition, for we need strong and brainy people in the country, and they are entitled to the same comforts and conveniences as are enjoyed by those living in the city.

Further, aside from its practical value, we should not lose sight of the fact that agriculture may be made an aid to other school work in many ways. Mathematics will be applied in the use of weights and measures, while the principles of percentage and proportion will enter into the solution of nearly every problem in soils. Composition will lose some of its bad flavor, and spelling will no longer be distasteful when applied to the description of experiments in which the pupils are interested. Manual training will find expression in the making of boxes, labels, farm levels, and many other appliances used in various experiments. Some of the principles of botany, physics, chemistry, and zoölogy will be learned and applied in their study with soils, plants, and animals. When handled in this way, all of the work will leave a more lasting impression, because it is concrete, and at the same time it will be more interesting because it is connected with the life and occupation of the pupils.

In the preparation of this work, the author has tried to keep constantly in mind the needs of the student as well as the facilities at the disposal of the teacher for making the instruction practical and available. No attempt has been made to exhaust the various topics treated, and in every instance abundant latitude is given the instructor to show his own individuality in developing and carrying out the ideas suggested by the text.

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PRACTICAL AGRICULTURE

I. COUNTRY LIFE AND FARMING

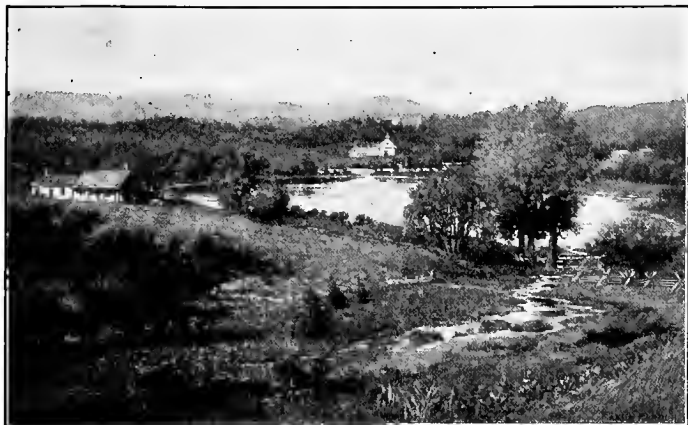
MANY young people dislike country life and think that they would be happier living in cities; but if their desires were realized, they would often find themselves somewhat disappointed. In the country there is plenty of pure fresh air, abundance of sunlight, and plenty of room for exercise and development, while the reverse is often true of our large centers of population.

On account of the height of the buildings in some portions of our large cities but little sunlight can find its way into the living rooms. In the tenement districts the homes are often overcrowded, and it is not unusual for one to find whole families living in a single room.

In the country there is always plenty of room, and such cramped conditions of living are never necessary. In fact, there are many reasons why we should prefer country life to city life, and why we should look upon farming as a most desirable calling. Upon farming, other occupations very largely depend for food and supplies. Of course there is a vast difference between good farming and the growing of crops in a haphazard way. People seem to think that crops can care for themselves after the seed is planted, and that the farmer's business is to cultivate the soil, destroy the weeds, and grow food enough for his own use. Were this true, farming would be very simple, and any one without training or experience could be a successful farmer. Farming is something more than the mere production of raw food materials from the soil. It is concerned not only with the growing of the staple grain, forage, and fiber crops, and the raising of stock, but also with the general management of lands and farms. Each kind of crop grown removes certain elements from the soil necessary for plant growth, and if the crop is taken away from the farm,

the soil is depleted and becomes less and less productive each succeeding year. The crops gradually decrease until they become unprofitable, and finally the land is abandoned. That is generally the result with unscientific farming where the farmer looks upon the land as an inexhaustible mine or reservoir upon which he may draw without any thought of the future.

The skillful farmer treats the land as a factory, and supplies the necessary crude elements as fast as they are transformed into



In the country there is plenty of room.

crops, thus keeping the land at the height of fertility. There is skill in farming as much as in any other occupation, and the more we reflect on the question, the more we are compelled to admit the necessity for studying the science of farming.

In its broad sense this science includes Agriculture, Horticulture, Forestry, Animal Industry, and Road Building.

Agriculture is the science which treats of the general management of lands and farms, and the production of useful plants and animals.

Horticulture treats of the growing of fruits, vegetables, and ornamental plants. It may be subdivided into Olericulture, Pomology, Floriculture, and Landscape Gardening.

Olericulture is the science which treats of vegetable growing and truck farming.

Pomology is the science or art of fruit growing.

Floriculture is the cultivation of plants for use as ornaments.

Landscape Gardening is the growing and planting of ornamental plants for their uses in mass effects in making up a landscape view.

Forestry is the growing of timber for lumber and wood, or for producing secondary effects upon any region by modifying the climate or by preserving the water supply for rivers and lakes.

Animal Industry is the science which treats of the proper management and feeding of animals for direct use or for the products they furnish.

Road Building. — Good roads are necessary in order that the perishable farm products may be got to market with as little delay and with as little expense as possible. In view of this fact, every farmer should know something about road building and road repairing.

QUESTIONS

1. Mention some of the benefits of country life.
2. What can you say of the advantages of city life?
3. What objections do you find to city life?
4. Discuss the effects of overcrowding in cities.
5. Why do so many of our young people leave the country for the city?
6. Why do some people look upon farming as a degraded calling?
7. How does the unskillful farmer regard his farm?
8. How is the land treated by the skillful farmer?
9. What does farm science include?
10. Define agriculture in its restricted sense.
11. What is horticulture, and what does it include?
12. Define olericulture, pomology, floriculture, landscape gardening.
13. What is forestry?
14. Define animal industry.
15. Why should every farmer know something of road building?

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II. THE HISTORY OF AGRICULTURE

IN early times there was much drudgery connected with farm life, and the lot of the farmer was hard, indeed. But few implements were used, and these were of a very crude type. The only form of plow known was a rude crooked stick which was drawn along the top of the ground by men or oxen. All seed was sown broadcast by hand, and when the grain was ripe it was cut with a reaping hook or a scythe. Thrashers were unknown and all grain had to be thrashed out by hand. This was generally accomplished by spreading the grain out on the barn floor or the ground and beating it with a flail. Sometimes the thrashing was effected by the treading of animals. Muscle and brawn ruled in these early days, and people were not accustomed to do much thinking or planning to better their conditions. Professor Davidson says: "The Roman farmer in the time of Columella spent four and six-tenth days in growing a bushel of wheat, while in 1830 the same amount of wheat could be grown under improved hand methods with three hours' work at a cost of 17.7 cents. At the present time under improved machine methods the same result may be secured with only nine minutes' work and at a cost of three and five-tenths cents." The change from the use of implements for hand production to those for machine production has relieved farm work of much of its drudgery and has at the same time greatly cheapened the cost of production of crops of every kind.

The widespread introduction of highly specialized and complex farm machinery has made it necessary that the farmer shall be a mechanic, while the close competition that has arisen in every line of production has made it obvious that all farm operations must be conducted according to scientific methods. Acquaintance with some of these methods may be gained through costly experience, but a systematic study of agriculture in the public schools, farmers' institutes, and State Agricultural Colleges of our country offers a more direct way to learn the facts of scientific agriculture.

Contrary to the popular belief, agriculture is not a new study by any means, although it is just beginning to receive attention in the public schools of this country. The Chinese nation made agriculture a part of its school course over four thousand years ago, but it must be admitted that its people have made slow progress in the subject, and that they are still following very crude methods of farming.

The Romans gave much attention to farming, and many of their statesmen spent their leisure moments in the country. The poems of Vergil, Horace, and other Roman authors extol the virtues of country life and show the high esteem in which the farm was held. As long as agriculture held the place of honor with the Romans and they lived on their own lands they waxed strong and conquered all nations that opposed them. But when at a later date the farms were neglected and left to the care of slaves, and the freemen flocked to the cities, the Roman nation began to decay and soon sank into obscurity. Their conquerors were the sturdy Teutonic tribes of northern Europe who lived out of doors and were strangers to city life. The ancient Egyptians cultivated the rich valley of the Nile and made it the granary and the storehouse of the world. The early Israelites or Jews were largely farmers and shepherds, and the sturdy characteristics of their descendants to-day are in a measure due to this fact. In New Mexico and Arizona there are abundant evidences that the ancient Indians of those regions gave much attention to agriculture. They were good farmers and thoroughly understood the necessity and benefits of irrigation in an arid region. They made the Salt River Valley of Arizona the garden spot of the West, and one may find to-day in the country surrounding Phoenix many traces and evidences of the former irrigation ditches and trenches made by these Indians. They reached a high state of civilization and built many cities, the ruins of which stand to-day as monuments to their thrift and industry.

In a general way we can say that nearly every strong and sturdy nation known in history has been a nation in which farming has been the chief occupation. England, Germany, France, the United States, and all the other strong nations of the world have established schools, experiment stations, and colleges for the instruction of their farmers in this great and useful science.

Our national government has made provision for the support of an agricultural college and an experiment station in every State and Territory, and it has proved to be one of the best investments that the national government has ever made. Oklahoma, which is one of the last States to be admitted into the Union, is to be especially commended for having adopted a constitution which provides that agriculture and domestic science shall be taught in all the public schools of the State. In many of our States agricultural high schools have been established, which are doing a great and good work. Georgia and Alabama in the South and Wisconsin in the North have done more, perhaps, along this line than any of their sister States. The time is not far distant when agriculture will be taught in every school of our country. When this has been done, we may expect a new era in farming and far more prosperous times.

QUESTIONS

1. Describe man's early struggle with the soil.
2. Mention some of the first farming implements that were used.
3. What has cheapened the cost of farm products of every kind?
4. Why is a systematic study of agriculture necessary?
5. Is agriculture a new study or subject?
6. What oriental nation early gave attention to agriculture and made it a part of the course of study for schools?
7. Discuss the position of agriculture among the early Romans.
8. What attention was given agriculture by the early Indians of North America? What proof have we of this fact?
9. Do our strong and vigorous men come from the country or the city? Why?
10. What steps have England, France, Germany, and the United States taken to promote agricultural education?
11. What States have taken the lead in establishing agricultural high schools?
12. For what is the constitution of Oklahoma especially to be commended?

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III. AIR AND SUNLIGHT

The Air. — The earth is surrounded by a mixture of several gases which we usually call the air or atmosphere. These gases and their average amount by volume are as follows:

Nitrogen	.	.	.	.	.	77.50 parts
Oxygen	.	.	.	.	.	20.64 parts
Argon	.	.	.	.	.	1.00 parts
Carbon Dioxide	.	.	.	.	.	.04 parts
Water Vapor	.	.	.	.	.	.82 parts
Total	.	.	.	.	.	100.00 parts

Besides these there are traces of other constituents, such as ammonia, nitric acid, dust, ozone, and a few other substances. About 5 per cent of the food of the plant is mineral matter from the soil and the other 95 per cent is made up of water (composed of hydrogen and oxygen), carbon, nitrogen, and oxygen, all of which are contained in air.

Carbon. — Our most familiar example of carbon in a solid form is found in mineral coal and charcoal. If we partly burn a pine splinter and note carefully the black substance that is formed, we find that it is carbon. When wood or coal is burned, the carbon in these substances unites with the oxygen in the air and forms an invisible gas called carbon dioxide.

All the carbon in the plant comes from the air, and while the amount of carbon dioxide present in the air seems relatively small, there is more than enough present to supply all the demands of vegetation. Professor Storer estimates that there is enough of this gas to approximate twenty-eight tons for every acre of the earth's surface. According to Professor Chevandier an acre of thrifty beech trees will assimilate about three tons of carbon dioxide in a year; and if the whole earth were covered with a forest of such trees, it would require more than nine years to consume all this gas

now present in the air. However, there is a never failing supply of carbon dioxide in the atmosphere, coming from the processes of combustion, decay, and fermentation. Another source is found in the respiration of animals, since they breathe in oxygen and give off carbon dioxide. In some localities large quantities of carbon dioxide are given off from mineral springs and volcanoes. This gas is also found in the pores of the soil, especially in regions where the soil is of limestone origin. The acids of the soils coming in contact with the limestone or calcium carbonate decompose this substance and liberate carbon dioxide. An illustration of this may be seen when a little hydrochloric acid is poured on some small pieces of marble. There is a brisk evolution of gas which on testing we find to be carbon dioxide. Its presence may be proved by passing the gas through clear limewater, which it soon clouds and makes a milky white. Its presence in the air we exhale may be detected in the same way. Carbon dioxide also has the property of extinguishing flames by shutting off the supply of oxygen necessary for combustion.

Since there are so many courses of carbon dioxide, there is no danger of the supply ever becoming exhausted. There is more than enough present to meet all demands of vegetation, and there would be no advantage gained by increasing the amount usually found in the atmosphere. On account of the principle known as diffusion in gases and the stirring action of winds the proportion of carbon dioxide in the air is kept remarkably constant. The ventilating power of the wind can scarcely be appreciated by any one who has not given any thought to the matter. Professor Storer of Harvard University says, "Air moving no faster than two miles an hour, which is almost imperceptible, if allowed to pass freely through an open shed, will change the air of the place 528 times in an hour. Hence, having regard to their respective requirements, carbon dioxide is, to all intents and purposes, supplied as freely to plants by the air as oxygen is supplied to animals."

The carbon in the atmosphere can be assimilated by plants only in the presence of light and through the chlorophyll or green coloring matter in their leaves. In the absence of light plants exhale carbon dioxide instead of oxygen. According to Professor Storer, plants exposed to the dull light of a cloudy day will sometimes

exhale carbonic dioxide and at other times oxygen, according to the intensity of the light and the state of development of the plant.

Oxygen is the life-giving principle in the air for man and animals. It is the most abundant substance of the earth, and comprises by volume about one fifth of our atmosphere. It is present in both plants and animals, both free and also in combination with other elements. Oxygen is just as essential for plants as for animals and it plays an important part in the chemical reactions that occur in the processes by which new cells are built up from the materials elaborated in the older cells. It has been found that seed will not germinate or sprout in the absence of oxygen. Young plants when deprived of it soon wither and perish. The young buds of trees on opening in the spring absorb oxygen from the air and experiments show that they wither and decay when confined in an atmosphere from which the oxygen has been removed. Oxygen is also taken up by flowers and ripening fruit. Mushrooms and lichens absorb oxygen very freely from the air and give off a corresponding quantity of carbon dioxide.

The amount of oxygen contained in vegetable matters is really very large, in fact it is much larger than we might suspect on first thought. About seventy-five pounds of every hundred pounds of vegetable matter consists of water, and since oxygen comprises eight ninths of the weight of water, it is evident that the oxygen from this source alone would amount to $66\frac{2}{3}$ pounds or to $66\frac{2}{3}$ per cent. When we add to this the amount of oxygen found in combination with other elements in plants and animals we can appreciate the important rôle it plays in the development of all forms of life.

Nitrogen is necessary for both plant and animal growth. Animals obtain their supply of nitrogen from plants and from animal food. Nitrogen inhaled with the oxygen is exhaled practically unchanged with the carbon dioxide. Leguminous plants, such as clover, alfalfa, and cowpeas, obtain a part of their supply of nitrogen from the air, but other families of plants secure nitrogen from certain nitrates in the soil, such as the nitrates of potash, lime, soda, and ammonia.

Hydrogen does not exist in the atmosphere in a free state, but is found combined with other elements. It unites with oxygen to

vessel of no material now known can confine it. In the limitless ocean of ether surrounding the sun innumerable waves are set up and transmitted in all directions. More than four hundred millions of them arrive at the earth every second, having come across ninety-three millions of miles in about eight minutes. It is under such hurried strokes as these that many of the processes of plant growth are produced.

To appreciate the true value of sunlight we have only to observe the sickly appearance of plants in the shade or in dark places. No doubt you have observed that the tops of many house plants incline towards the source of light. In New Mexico, near Roswell, one may frequently see the same thing illustrated in the long rows of cottonwood trees lining the banks of irrigating ditches which border many of the roadways and drives. Florists sometimes arrange window plants on a revolving platform in order to secure an equal distribution of the light and an even growth of the plant. From this it will be seen that plants must have plenty of sunlight in order to develop.

EXERCISES

1. Place some marble or limestone in a glass or a bottle, and add a little hydrochloric acid. Test the gas that is formed and ascertain what it is.
2. Blow your breath through limewater by means of a straw or a glass tube. Note the results and explain.
3. Plant a few grains of wheat or corn in two tomato cans filled with good soil. Puncture the bottom of one of the cans and give the seed and soil in this can only a moderate quantity of water from time to time as needed. Keep the soil in the other can water-soaked so as to exclude the air as much as possible. Note the results and explain.
4. Place two cans or pots containing plants in the window where the light can shine on both. Label one of the cans *A* and the other one *B*. Adjust the position of the one marked *A* several times each day so that all parts of the plant will have an equal chance at the light. Do not change the position of *B* at all; and compare results in the development of the two plants. Explain.
5. Grow plants both in the shade and the sun. Explain results.

QUESTIONS

1. Discuss the composition of the air.
2. What part of plant food is derived from (a) the soil, (b) the air?
3. In what forms does carbon appear?

4. What is said of carbon dioxide?
5. What can you say of the relative amount of this substance?
6. Mention the natural sources of carbon dioxide.
7. Explain how carbon dioxide may be prepared artificially and how its presence may be detected.
8. Through what means are the gases in the atmosphere kept evenly distributed?
9. Is the popular belief that plants inhale carbon dioxide and exhale oxygen always true? Explain.
10. What effect has darkness and cloudy weather on the respiration of plants?
11. In what forms is oxygen found in plants and animals?
12. What effect has oxygen on the germination of seeds?
13. Discuss oxygen in its relations to young plants, young buds, flowers, and fruit.
14. What plants inhale oxygen and exhale carbon dioxide?
15. What can you say of the amount of oxygen present in vegetable matter?
16. Discuss nitrogen and its relations to plants.
17. What is said of hydrogen?
18. Discuss air pressure.
19. How is the earth kept warm?
20. Discuss sunlight and its action on plants.
21. What is chlorophyll?
22. How is all plant food formed?

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IV. WATER

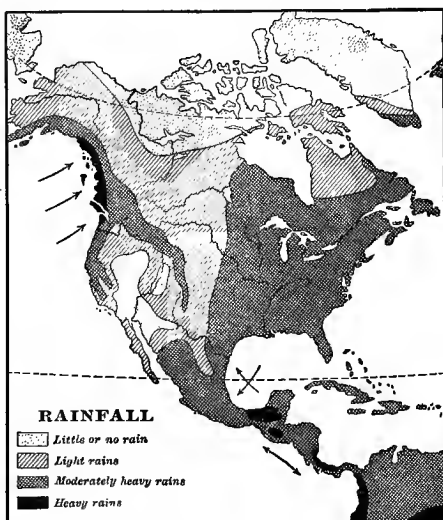
WATER is composed of two substances, hydrogen and oxygen, in the proportion of two volumes of the former to one of the latter. A fresh living plant consists largely of water. Young grass and fresh potatoes are about three fourths or 75 per cent water, which may be driven off by continuous heating to 212° F., the boiling point of water under normal conditions. Beets and carrots contain from 80 per cent to 90 per cent of water. They are constantly absorbing water through their roots and giving it off through their leaves. Carefully conducted experiments show that for every pound of dry matter in oats three hundred and seventy-six pounds of water are required, three hundred and thirty-eight pounds for wheat, and three hundred and ten for red clover. If we assume that about 80 per cent of clover is water, we can easily calculate how much water would be used up in growing ten acres of clover weighing about twelve thousand pounds. Trees as a rule contain less than one third their weight of water. This percentage increases during the spring and decreases slightly in the winter. The amount also varies for different trees. From monthly determinations it has been found that the average yearly amount of water in a pine tree is 61 per cent, in a poplar 53 per cent, in a birch 49 per cent, and in a maple 42 per cent.

Water is one of the most abundant substances found on the earth. Curiously enough we find here, as in the case of plants, that about three fourths of the earth's surface is composed of water, while only one fourth is land. Water is also present in the air in the form of vapor. The amount, which we call humidity, varies greatly in different parts of the United States. In the States along the Gulf Coast and a narrow belt along the sea in Oregon and Washington, the humidity is great and the rainfall is from fifty to sixty inches. On the other hand there are districts in Nevada, Arizona, and Utah where the rainfall is less than five inches a year. The explanation is found in the fact that the moist air from the

ocean loses much of its moisture in passing the coastal mountains. The warmer the air becomes the more water vapor it can hold. The sun's heat falling on the moist earth and the water causes evaporation. On dry, hot days the air is like a great sponge and drinks up moisture from the earth, plants, and everything with which it comes in contact. When there is much moisture present in the air and the temperature is high, we say the weather is heavy and sultry. The warm, humid air can absorb but little moisture, and hence drops of perspiration collect on the body. In dry, arid regions there is little moisture present, and the rate at which evaporation goes on is rapid and so perspiration does not collect on the surface of our bodies.

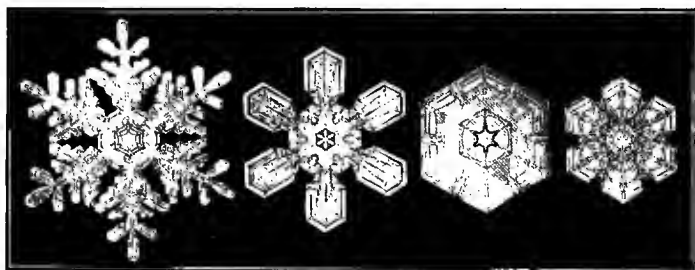
Whenever evaporation takes place there is always a lowering of temperature. In Arizona water is often placed in porous earthen vessels, which are hung up where the breeze or a draft of air can strike them, and the evaporation going on from the surface of these vessels is sufficient to cool the water until it is almost like ice water.

Another point we should remember in considering the humidity of the air is that, when the sun's heat is removed, the air grows cool, and its ability to hold moisture decreases; and as the temperature continues to fall, a point is soon reached where the vapor will condense on the grass and the leaves of the plants and also on roofs and stones. This is called dew, and the temperature at which it begins to form is called the dew-point. Do not jump at the conclusion that all the drops of water you see sparkling on the trees and grass have come from the air, for many of them have worked their way from the ground through the plant



and have been transpired; that is, breathed out, by the leaves. On cloudy nights dew is not likely to form because the clouds act like a great blanket and prevent rapid cooling of the ground, so that the temperature of the earth and the air in contact with it do not differ enough to favor the condensation of moisture. Again, when high winds prevail, moisture is evaporated as fast as it condenses and hence no dew is formed. Frost may be regarded as frozen dew; that is, the surplus moisture in this case is frozen as it reaches the point of condensation.

Clouds prevent frost by holding in the heat which has accumulated during the day, because any heat radiated into space is



Snowflakes.

caught by the surface of the clouds and is thrown back to the earth. We often effect the same result by placing coverings over plants on cold nights to protect them from frost. High winds cause rapid evaporation and so prevent frost. Again, the warm air, being lighter than the cold air, which drives it out of the valleys and lowlands, covers the hills and ridges and so often protects plants from the damage done by frost, while in the low places vegetation suffers severely from its effects. Dust and smoke also act like clouds in stopping radiation and preventing frost.

If a few feet or a few hundred feet of the lower air cool to the dew-point, a fog is formed in place of dew. The particles of invisible vapor unite and become visible, but are so light that the air still supports them. Clouds do not differ very materially from fogs except that they are formed higher in the air. They are seen at heights that vary from a few hundred yards to distances ranging from five to ten miles above sea level. Finally, these fine particles

of water unite and form drops of water which fall to the earth in the form of rain. If these drops are frozen, hail results. If the vapor condenses in a region where the temperature is below the freezing point, the moisture forms crystals of ice of various forms, and these fall as snow. Moisture in the air serves another purpose in helping to keep the earth warm. The lower and denser air is heated by the sun's rays passing through them, and the moisture acts as a blanket to prevent the loss of this heat by radiation.

EXERCISES

1. Place a glass tumbler of ice water in a warm room and note the results. Repeat the experiment and direct a current of air against the glass by fanning or by some other means, and note whether the amount of moisture condensed on the surface of the glass is the same as before.

2. Take two thermometers and see that they read the same in the beginning. Now cover the bulb of one of the thermometers with a wet cloth and place it in the wind where evaporation will be favored, and note whether this thermometer reads the same as the one with the dry bulb. Account for the difference.

3. Weigh a potato, then heat it until all the water is driven off, and weigh again. Compare the relative weights, and estimate the percentage of solid mineral material and the percentage of water found in the potato.

4. Weigh a green plant, then hang it up in the air for several days. When it is thoroughly dry, weigh again. Note the difference and explain.

QUESTIONS

1. What is the composition of water?
2. What per cent of the plant is composed of water?
3. Discuss the amount of water required by a plant in making its growth.
4. Do seasons affect this? Explain.
5. Discuss the distribution of rainfall in the United States.
6. Discuss (a) evaporation, (b) dew, (c) fog, (d) frost.
7. How many pounds of water are required to grow fifty bushels of (a) oats, (b) wheat?
8. How do clouds prevent frost?
9. What effect have winds on the formation of frost and dew?
10. Explain why plants on high ground frequently escape injury when plants on low ground are frost-bitten and killed.

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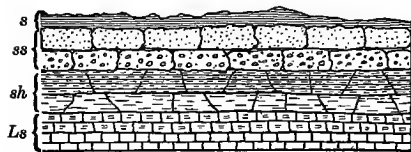
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V. THE SOIL

Soil Defined. — Soil consists of finely divided rock fragments with which air, water, certain living organisms, and parts of decaying plants or animals are mixed. On it cultivated plants may be grown. Ordinarily, the term is applied to the first six to twelve inches of the earth's surface in which plants may be grown.

The Subsoil. — The harder and colder earth under the top soil or surface layer is called the subsoil. It differs from the top soil in that it contains less vegetable matter, is less finely divided, and is more compact. Sometimes there is a sharp line of demarcation in the color of the two portions; when the deeper soil is brought to the surface it is found to be unproductive in some cases. However, in arid regions these distinctions do not always appear. In Arizona and some of the other western States the soil from a depth of thirty feet or more is frequently found to be quite productive. The subsoil renews the minerals depleted in the top soil and also acts as a retaining medium for the roots of plants and trees and as a storehouse of moisture.

It is estimated that the first eight inches of soil on each acre contain over three thousand pounds of nitrogen, nearly four thousand pounds of phosphoric acid, and over seventeen thousand pounds of potash. Still, the soil itself furnishes no more than 10 per cent of the weight of plants and often much less.



Relative positions of soil, subsoil, and underlying rock strata: *s*, soil and subsoil; *ss*, sandstone; *sh*, shale; *Ls*, Limestone.

Hard Pan. — Sometimes the subsoil after becoming

very closely packed and dry forms a kind of hard layer or stratum of earth which we call hard pan. Beneath this we find rich porous earth, but it is of no service to the plant unless in our cultivation we break through the hard pan. In some parts

of Oklahoma, Arizona, and New Mexico, nurserymen frequently place a stick of dynamite in this hard pan layer and blast openings in it where young trees are to be planted. Unless this is done, the trees grow very slowly and frequently die.

Origin of Soils. — All soils have been derived directly or indirectly by the disintegration of rocks, generally through the prolonged action of heat, cold, air, water, frost, and ice. In some cases, however, this was brought about by the action of low but



The Mississippi flowing through an alluvial plain.

tiny forms of vegetable and animal life. These rocks may be roughly put into two classes: (1) igneous rocks; (2) aqueous rocks.

Igneous rocks are those which have been produced by the action of fire. Granite and trap are the two best examples.

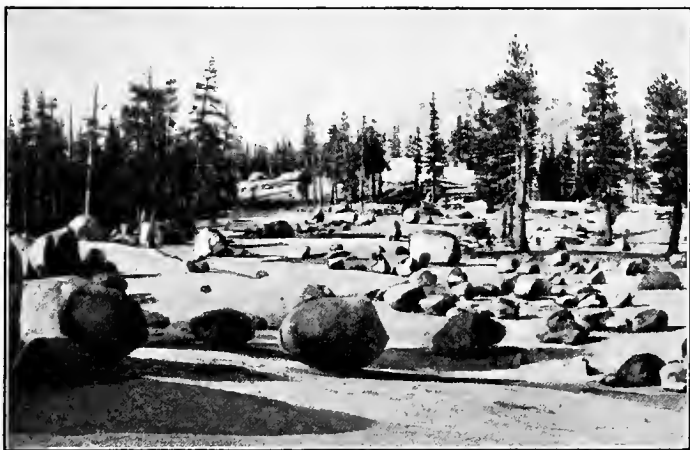
Aqueous Rocks. — These are produced by the action of water. As examples of aqueous rocks, limestone and red sandstone may be mentioned.

Other Classes of Soils. — With reference to their origin, soils may be divided into: (1) sedentary soils; (2) transported soils, consisting of (a) alluvial soils, (b) drift soils, (c) wind blown soils.

Sedentary Soils. — These are soils which rest upon the rock from which they were formed. Their composition is similar to that of the rock underneath, with vegetable matter added by the growth of plants upon them.

Transported Soils are those that have been deposited from water and ice after being transported, perhaps, hundreds of miles from the parent rock.

Alluvial Soils. — Soils deposited from water are called alluvial. They form fertile loams and are usually rich in organic matter.



Boulders deposited by a glacier.

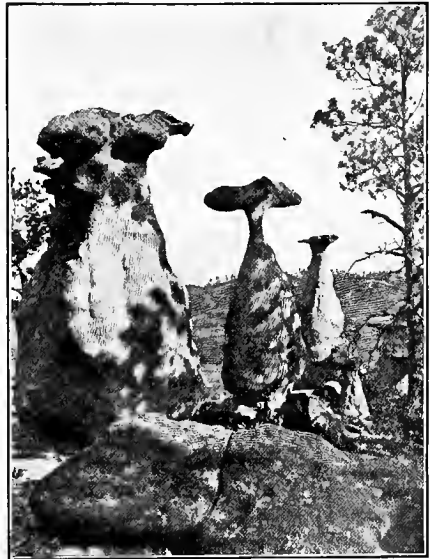
These alluvial soils occur in valleys, river beds, and also in beds of former lakes now far inland.

Drift Soils. — Soils deposited from ice are called drift soils. They may be distinguished from others by the presence of round rocks or boulders. They are formed by the action of glaciers which are vast bodies of ice moving like a river carrying vast quantities of earth and stone.

The Glacial Age. — Many hundreds of years ago there came a long cold winter which destroyed nearly all forms of plant and animal life. Snow and sleet fell day after day until an immense glacier or body of ice several hundreds of feet in thickness was formed. One of these glaciers, a thousand feet thick and a thou-

sand miles wide, extended from the Arctic region southward over a large part of the northern portion of the United States, grinding rocks, tearing down hills, and filling up valleys. Many of these rocks worked their way through the ice, and, moving with the ice, scoured the solid rock underneath until ground into powder. Finally, when the glacier melted, the fine powdered rock was deposited and formed a productive soil made so by the assembling of a variety of mineral elements. It is thought that this great mantle of ice at one time reached to the fortieth parallel of latitude in North America.

Wind-blown Soils. — In some countries we find that heavy winds stir up the soil and move it from one place to another. This is especially likely to happen in sandy regions. Frequently these small particles of sand and dust will be blown with such violence that they will scour off and



Rocks worn by wind-blown sand.

dislodge other particles of soil on high ridges and ledges in exposed places. The cutting and scouring force of sand when driven by high winds is much greater than one would ordinarily expect. On the Great Plains in the West telegraph poles are frequently worn away and cut almost through at the base where these drifting sands come in contact with them. Along the Coast Route of the Santa Fé Pacific in California the sand in some places drifts so upon the railroad tracks that high board fences have to be built to keep the tracks from being covered by the drifting sand. Similar conditions exist in various places along the Gulf coast, the Atlantic seaboard, and the shores of the Great Lakes in the northern and northeastern part of the

United States. Sometimes in Nebraska, western Oklahoma, Kansas, and Texas there are dust storms of such violence and intensity that the heavens are darkened and obscured as if covered with a heavy cloud. About March 13, 1904, a dust storm swept over western Kansas and northwestern Oklahoma, which was so heavy and dense that day was turned into night of inky blackness. The next morning everything was covered with a heavy layer of dust. The damage from the storm was slight, while the enrichment of the soil by the addition of these accumulated dust particles was considerable. In many parts of the United States we find these wind-blown soils, and in many cases they are fertile and very productive.

EXERCISES

1. With a soil augur ascertain the depth of soil and subsoil in your locality.
2. At what depth is rock found?
3. Classify the soils found in your vicinity.
4. Secure samples of the various rocks in your county and classify them.
5. Make a mixture of rocks, pebbles, sand, and soil, and stir them up well with a stick or iron poker after adding enough water to make a thin paste of the soil. Allow the mixture to settle and note the results. Explain. A fruit jar or a candy jar will be found useful for this experiment. If this cannot be had, use smaller pebbles and place the mixture in a glass tumbler.
6. Build up a soil bed of sand, gravel, and soil and cause a stream of water to pass through the bed; note the shifting and arrangement of soil particles. Explain.

QUESTIONS

1. Define soil.
2. Define subsoil.
3. What is hard pan?
4. Discuss the origin of soil.
5. Discuss rocks.
6. Describe igneous rocks.
7. Describe aqueous rocks.
8. Discuss sedentary soils.
9. Give the classes of transported soils.
10. Discuss alluvial soils.
11. Discuss drift soils.

12. Give an account of the glacial age.
13. Discuss wind-blown soils.
14. Discuss the effect of dust storms on soil.

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VI. SOIL INGREDIENTS

THE most important ingredients of soil are sand, clay, lime, and organic matter.

Sand. — Quartz sand is composed chiefly of silica. It contains very little nutriment for the plant, but it makes soils porous and loose, so that air and moisture may reach the roots of the plant. It also raises the temperature of the soil, as it is rapidly heated by the sun's rays. Water works its way very easily through sand and dissolves no appreciable amount of it. Hence it holds but little moisture and soon dries out. This being the case, it is not surprising that very sandy soils are poorly adapted to plant growth.

Clay consists of very fine particles of certain rocks. Ordinarily it contains a mixture of silica and alumina with certain impurities, especially potash. Although not a valuable plant food, clay has the important property of absorbing and retaining phosphoric acid, ammonia, lime, and other substances which are needed in plant nutrition. Pure clay has no grit in it, but feels smooth and velvety. When mixed with water it becomes sticky and forms a pasty mass like putty. Silt is like clay in composition but its particles are larger.

Sand and Clay Compared. — If we examine sand and clay closely, we find many points of difference. Moist clay sticks closely together and may be molded into almost any form, while sand readily falls apart. Water readily passes through sand, while clay retains it. The sun's rays are more readily absorbed by sand than by clay, and hence a soil containing sand is always warmer than one containing clay. If you have a thermometer, compare the temperature of a pint of sand with the temperature of a pint of pulverized clay. Then place each sample in a tomato can and after pouring a moderate quantity of water on each see which one dries out first.

Loam. — A soil containing a mixture of sand and clay is called a loam. If the clay predominates, it is known as a clay loam. If the sand is largely in excess, it is called a sandy loam.

Lime is a valuable constituent of plants and is beneficial to the soil in many ways. It aids in the formation of nitrates in the soil and promotes the decomposition of vegetable matter. When present it overcomes the sticky tendency of the particles of clay and renders the passage of water through them very easy. The absorptive and retentive power of sandy soils is improved by it. In many northern climates, like Alaska, lime is necessary to neutralize the acids in the soil, and when lime is not used cultivated plants will grow scarcely at all in such soils.

Humus. — By humus we ordinarily mean the decaying organic matter in soils made up of carbon, oxygen, hydrogen, nitrogen, etc. The fertility of virgin soils is largely due to the nitrogenous humus present, which is derived largely from the dead roots, branches, and leaves of a former vegetation.

Humus absorbs a great deal of water by reason of its porosity, and this water tends to keep the soil cool. It also warms some soils by absorbing the sun's rays. It is valuable as a manure because of its power to supply nitrogen. It is also valuable because of its power to absorb and hold ammonia and ammonia salts. It promotes chemical action in the soil and supplies the carbon dioxide needed for the disintegration and solution of some of the mineral matters in the soil used as plant foods.

Humus greatly improves the texture of certain soils. It binds sandy soils and lightens heavy clays, when applied in proper quantities. For soils naturally too dry for cultivation or likely to bake and crack open during a summer drought, additions of humus are very beneficial. Wet soils are not benefited by it, for it tends to hold the moisture.

The greatest amount of humus is found in temperate climates, where the soil is too damp and cold to permit the rapid decay of organic matter during a considerable portion of the year. In tropical regions and arid regions the amount of humus found is relatively small compared with the amount in temperate climates.

The importance of humus as a plant food is still questioned by some authorities. Professor King says: "It used to be held that any soil deficient in humus was, because of this shortage, necessarily poor or sterile; but it is now known that in arid regions, where humus in the soil is very scanty or even wanting, large crops

are produced when only an abundance of water is supplied. Experiments in water culture, too, have proved that when nitrogen is supplied to plants in the form of purely inorganic or mineral nitrates, plants will thrive in the complete absence of humus."

EXERCISES

1. Secure samples of clay, sand, and loam. Expose them to the action of the sun for an hour and note the temperature.
2. If possible secure samples of humus and mix with each of the soils previously mentioned. After moistening them thoroughly repeat the previous experiment and note temperatures as before. Explain the results.
3. Secure dry samples of clay, sand, and soil and weigh each sample. Add equal weights of water to each and after exposure to the action of the sun for a day record the weights again. Note results and explain.
4. Plant seed in each sample of soil and note the time required for germination. Explain the results.

QUESTIONS

1. Name some of the soil ingredients.
2. Discuss sand and its value as a soil maker.
3. Discuss clay and its properties.
4. Of what does clay consist?
5. In what way is clay valuable to plant growth?
6. Compare sand and clay.
7. Explain what is meant by loam.
8. Discuss lime and its action on soils.
9. Discuss humus and its formation.
10. What effect has humus on sandy soils?
11. Discuss the action of humus on clay soils.
12. Should humus be used on wet lands? Why?
13. Where is the greatest amount of humus found? Why?
14. What does Professor King say about the importance of humus as a plant food?

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VII. TYPES OF SOIL

Light and Heavy Soils. — We frequently hear farmers speak of light and of heavy soils, but we should remember that the terms *light* and *heavy* as applied to soils have usually no reference whatever to weight, but refer solely to the amount of force which has to be exerted in tilling the land. In fact, most so-called light soils really weigh more than the heavy soils. Peat-laden soils are usually light in both senses of the word. Schuebler in his experiments, after heating a cubic foot of various soils for half an hour at temperatures ranging from 100° to 122° F., found the following weights:

Quartz Sand	100-110 lb.
Clay	68-75 lb.
Garden Loam	76 lb.
Clayey Loam	88 lb.
Vegetable Mold	31 lb.
Peat	30-50 lb.

Warm and Cold Soils. — Soils are called warm or cold according to their power of holding the sun's heat. The amount of heat taken up and retained varies greatly for different soils. Oemler in his experiments with air-dried soils obtained the following results:

KIND OF SOIL	PERCENTAGE OF ABSORPTION
Moor Earth	100
Sandy Humus	95
Loam Rich in Humus	90
Clay Rich in Humus	87
Light Gray Clay	81
Coarse Sand	84
Pure Chalk	87

Besides the nature of the soil constituents we find that the color of soils also has a marked influence on the temperature. A dark soil is always warmer than a light soil. In southern France it is found that chalk soils are always late because of their color. In some mountainous countries of Europe the inhabitants procure black earth, which they sprinkle over the snow in the spring in

order to hasten the melting of the snow. This is done because in such elevated situations the summers are of such short duration that it is of great importance to save time in getting the ground ready for the seed and having them sprout as soon as possible. Gasparin in his experiments found as much as twelve to fourteen degrees difference in temperature between two samples of soil similarly exposed to sunlight if one of the soils was made white by covering it with magnesia and the other made dark by covering it with lampblack.

The amount of heat absorbed is also affected by the composition of soils and the fineness of the soil particles. Clay soils are generally much colder than sandy soils, but coarse rocky soils often suffer from extremes of temperature.

The matter of location or relative position is also an important factor. We know from observation that the southern sides of hills, walls, or other wind-breaks are generally the warmest. In the vicinity of Boston farmers usually choose the southern slopes of hills, even where the soil seems to be poor and gravelly, for growing early vegetables. But light loose soils in such positions frequently become overheated and so dry in midsummer that crops growing upon them soon wither away and perish. The direction of the cultivation is also an important matter that should not be overlooked. Experiments show that crops cultivated in beds running from north to south will be more equally warmed than if the beds run east and west. In very many cases it is found that flat cultivation insures a more equable temperature than the opposite arrangement.

Farm Soils. — We find that soils vary greatly in the way they are made up. It is obvious that different kinds of rocks in their decay make different kinds of soil. The principal types of soil are as follows:

- | | |
|---|---|
| <p>Classes with reference to constituents</p> | <p>{</p> <ol style="list-style-type: none"> 1. Sandy Soils 2. Clay Soils 3. Loamy Soils 4. Limestone 5. Buckshot Soils 6. Vegetable Soils 7. Alkali Soils <p>}</p> |
|---|---|

Classes with reference to moisture	{	1. Arid
		2. Semiarid
		3. Humid

Sandy Soils. — A sandy soil contains over 70 per cent of sand. Such soils are easy to work but are poor in plant food. They absorb and retain but little moisture. Quick-growing crops are best adapted to this kind of soil.

Clay Soils. — Soils which contain over 50 per cent of clay are called clay soils, and may be easily recognized by their sticky character. Such soils are cold and hard to work and suffer from extremes in both wet and dry weather. Cereals and grasses are best adapted to this kind of soil.

Loamy Soils. — Soils which consist of a mixture of sand and clay are called loams. They may be classified as follows: (1) sandy loams, containing from 10 to 20 per cent of clay; (2) ordinary loam, containing from 20 to 30 per cent of clay; (3) clay loam, containing from 30 to 50 per cent of clay; (4) limestone loam, containing from 20 to 40 per cent of clay. Loams are suitable for nearly all farming purposes. This kind of soil is frequently found in the great black prairie belts in Missouri, Illinois, Iowa, Kansas, Texas, Mississippi, Alabama, and in some of the eastern portions of Oklahoma.

Limestone Soils. — Calcareous or limestone soils are those which contain 20 per cent or more of lime. Such soils crumble readily and are easy to cultivate.

Vegetable or Swamp Soils. — Such soils consist almost entirely of vegetable matter more or less decayed and are usually found in lowlands or low places. The best examples of this soil are found in the Great Dismal Swamp of Virginia and North Carolina and the Everglades of Florida. When well drained and properly treated, such soils are very productive.

Buckshot Soil. — Some limestone lands in Texas, Oklahoma, and other States contain so much lime that the soil is very sticky and gummy when wet, but it readily crumbles into small particles or pellets when dry. For this reason it is often called gumbo or buckshot land. In the northeastern part of Oklahoma patches of this kind of soil are sometimes encountered, while in Texas it is

quite common on the black prairie lands. It is especially noticeable in Dallas County, Texas.

Arid Soils. — In Arizona, New Mexico, Utah, Nevada, and some of the other western States there is so little rainfall that the soils



Giant cactus, Arizona

are practically unwatered and are too dry for the growth of ordinary vegetation. In such regions only a few hardy plants such as the Spanish bayonet, the yucca, and various kinds of cactus will grow without irrigation.

Alkali Soils are those containing large deposits of mineral salts which check vegetable growth. Alkali soils are not generally encountered in humid regions because the rain leaches out the saline materials. These soils occur in the western part of the United States in the arid or semiarid regions. The alkali usually present is carbonate of soda. When more than one fourth of 1 per cent is present, it prevents germination of seed.

It makes the soil break up in clods and the furrows do not crumble to powder in drying, which is an essential feature of good tillage. It may be remedied by tile draining and suitable irrigation. If we have irrigation without the drainage, we only aggravate the difficulty and increase the accumulation of saline matters at or near the surface. For the water thus used carries the alkali with it, but as it does not reach the natural drainage it rises again when evaporation begins; and if all the water evaporates, the whole of the alkali will come towards the surface. In parts of Argentina it is said that the whole country is quickly covered with scattering plants while the rains last, but as soon as the dry hot weather comes, the alkali rises and kills nearly all vegetation. The ground

becomes whitened with incrustations of alkali in many places to such an extent that it looks like a white mantle of snow. A large part of the lands in the arid regions of the United States are alkaline in their nature, and white alkaline incrustations may often be seen along the banks of streams and of many of the irrigating ditches found in this region. Such soils are often very fertile, as they have not been leached out by heavy rains; consequently they yield large returns when properly cultivated and sufficiently irrigated. The Salt River Valley and the Gila Valley of Arizona, the Pecos Valley of New Mexico, together with portions of California, Colorado, and Nevada, are striking examples of this fact.

Semiarid Lands. — In northwestern Texas, and also in the western portions of Oklahoma, Kansas, and Nebraska we find lands that are only half watered and are designated as semiarid lands. These soils are of a loose sandy nature and contain sufficient moisture to insure a good growth of wild prairie grass and buffalo grass during the greater portion of the year. The rainfall here varies from five to twenty-five inches.

Humid Soils. — These are soils that have plenty of rain and moisture. Vegetation of such soils is of rapid growth on account of the moisture present, but they really contain much less plant food than arid lands because the heavy rains wash away the nutritive elements of the soil. Characteristic soils of this kind are found in the Mississippi River Valley region and in many other parts of the United States. In some portions of the State of Washington the rainfall frequently is over one hundred inches per year.

EXERCISES

1. Secure a pint of sand, a pint of clay, and a pint of ordinary soil. Weigh each and record your results.
2. Heat each sample for some time and weigh again. Explain the results.
3. Place each sample in a vessel and add much water. Drain off the water not absorbed and weigh again. Note results and explain.
4. Expose each sample to the action of the sun and wind. Note results and explain.
5. Plant some seed in each sample of soil and watch the growth rate and development.
6. Test the temperature of the samples of soil used above and compare the temperatures.

QUESTIONS

1. Discuss light and heavy soils.
2. Discuss warm and cold soils.
3. What effect has color on soils?
4. What effect has location on the temperature of soils?
5. Which will be warmed more equally, plants set in rows running east and west or those running north and south? Why?
6. Name the classes of soils with reference to constituents.
7. Name the classes of soils with reference to moisture content.
8. What are sandy soils? Clay soils?
9. Discuss loamy soils.
10. What are limestone soils? Vegetable soils?
11. Explain what is meant by buckshot soil.
12. Discuss arid soils and alkali soils.
13. What are semiarid soils?
14. Discuss humid soils.

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VIII. CHEMICAL COMPOSITION OF THE SOIL

THE substances that enter into the composition of the soil may be roughly divided into two general classes: organic and inorganic. The organic elements are derived chiefly from the decay of plants and animals and comprise less than 10 per cent of the soil. The inorganic elements are derived from the decay of rocks which form the surface.

The Metallic Elements. — More than 90 per cent of the soil is mineral matter composed of metals and non-metals. The metals which are of the most importance to agriculture are:

Aluminum	Manganese
Calcium	Potassium
Iron	Sodium
Magnesium	

Aluminum is a beautiful white metal which is very abundant in the earth's surface. It is one of the chief constituents of clay, which plays an important part in the water-holding power of soils.

Calcium is a yellowish colored metal that enters into the composition of limestone and gypsum. In limestone it occurs in the form of calcium carbonate and in gypsum it occurs as calcium sulphate.

Magnesium is a hard white metal and is an indispensable plant food. Both magnesium and calcium collect chiefly in the seeds of plants.

Potassium is a soft white metal which is widely distributed in the earth's crust. It is one of the essential elements of plant food. Its compounds are very soluble and hence are rapidly leached out and carried away in drainage waters.

Sodium is a soft white metal so light that it readily floats on water. It is widely distributed, and in the form of sodium nitrate it is largely used as a fertilizer. Vast beds of this nitrate are found in Chile. Sodium is also the basis of common salt, which is known to chemists as sodium chloride.

Iron is one of our very common metals. United with oxygen and water it forms the yellow and red ochres used in painting. It also enters largely into the coloring matter of red and yellow soils. Iron is an important plant food and is very abundant in the soils everywhere. It forms generally from 1 to 7 per cent of the soil.

Manganese is a grayish white metal and is very heavy. Like iron, it is somewhat abundant and is a valuable constituent of the soil.

Non-metallic Elements. — The elements found in this class are of very great importance to plant growth and form a large part of its food. They may be grouped as follows:

Oxygen	Chlorine
Silicon	Phosphorus
Carbon	Nitrogen
Sulphur	Fluorine
Hydrogen	Boron

Oxygen is a colorless substance which comprises about 23 per cent by weight of the atmosphere, eight ninths of the weight of water, and 50 per cent of the earth's solid crust. In gaseous form it is the life-giving principle of the atmosphere, without which animal life is impossible.

Silicon comprises about one fourth of the earth's soil and is the second most abundant element of the soil ingredients. It is found in the husks of grain and in the tissues of nearly all plants, but its presence is not indispensable.

Carbon occurs in the soil as a part of the humus or organic matter, but the plant gets the carbon of its food from the carbon dioxide of the air. Gaseous carbon dioxide is the product of a great number of reactions which take place on the earth's surface. It is generated in the combustion of carbon and organic matters, in the respiration of animals, and in the processes of decay and fermentation. It also issues from the soil in many volcanic regions.

In plants carbon appears as one of the elements of starch and it is especially abundant in the seeds of leguminous plants, in cereals, and in potatoes.

Sulphur is a pale yellow substance which generally occurs in the soil united with some metal as iron, lime, or magnesia. The characteristic odors of garlic, onions, and some other vegetables are due to the presence of sulphur. It is an essential part of many organic compounds in the tissues of plants and animals. Its presence in eggs is readily shown by its action on silverware, which it blackens.

Hydrogen is a colorless substance which may be obtained in gaseous form by the decomposition of water. It plays its greatest part in agriculture while combined with oxygen in the form of water, which is so essential to both animal and plant life.

Chlorine is a greenish yellow substance which has a suffocating odor. It is generally combined with sodium and in this form is known as common salt, which occurs in all soils and natural waters. It is present in most plants and seems to be an essential element.

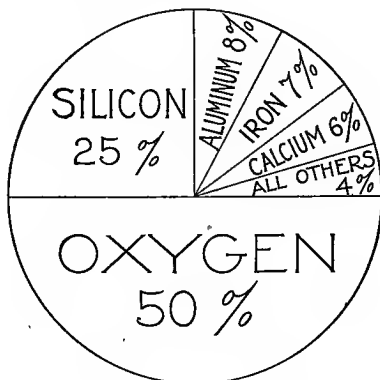
Phosphorus is a soft pale yellow substance obtained from bone ash. It is present in several forms in the soil and is an important ingredient. A part of the phosphate found in bone ash and in nature is insoluble in water until treated with sulphuric acid.

Nitrogen is a colorless substance comprising in gaseous form about four fifths of the atmosphere and is a constituent of animal and vegetable matter. In spite of its great abundance in the air, it is one of the least abundant in the soil. Here it occurs as a part of the humus and the fragments of the decaying tissues of plants and animals. Nitrogen is being constantly taken from the soil in the form of nitrates, and in order to preserve the fertility of the soil nitrogen must constantly be supplied. This is usually done by allowing nitrogenous organic matter to decay upon the soil or by adding to the soil a fertilizer containing nitrogen compounds.

Fluorine is a pale yellow substance which has a powerful odor. United with lime it occurs in fluorite. Fluorine is a constituent of the blood, milk, teeth, and bones of animals.

Boron. — Borax is the most familiar compound in which boron occurs. In this form it is largely used as a preservative for sausage, canned meats, fish, milk, butter, beer, and wine. Boron is not a very common element, but in the form of borax is found in the United States, principally in California and Arizona.

Below is a diagram showing roughly the distributions of elements in the earth's crust. Of the last 4 %, 1.3 % is magnesium, 1 % is sodium, 1 % is potassium, and all the remaining elements do not quite equal 1 % of the earth's crust.



QUESTIONS AND EXERCISES

1. Name the two great classes of elements that enter into the soil.
2. Name the metallic elements.
3. Describe (a) aluminum, (b) calcium.
4. Discuss (a) magnesium, (b) potassium.
5. Describe (a) sodium, (b) iron, (c) manganese.
6. Name some of the non-metallic elements of the soil.
7. Discuss (a) oxygen, (b) silicon, (c) carbon.
8. Describe (a) sulphur, (b) hydrogen, (c) chlorine.
9. Discuss (a) phosphorus, (b) nitrogen.
10. Describe (a) fluorine, (b) boron.

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IX. SOIL MOISTURE

WE have just seen that the soil is richly stored with all kinds of food for plants, but none of it can be absorbed so long as it remains in a dry state. The minerals of the soils are dissolved by the water which conveys them to the roots and from there through the stem and branches to the leaves, where they are prepared for food and taken wherever needed. The cells in all parts of the plant, even to the remotest root tips, are fed by this leaf-formed food. It is estimated that more than four fifths of the weight of a growing plant is water. Besides the water found in the plant a large portion is being constantly exhaled by the leaves. This may be readily proved in two ways. If we put a drinking glass or a fruit jar over a small growing plant, in a short time the inner surface of the vessel will be covered with moisture. Again, if we place a freshly cut leaf or twig with its stem in water, it will live for some time; but if we place it in the vessel without adding the water, it soon withers and dries to a crisp. It is estimated that an acre of grass land will exhale in a day's time more than thirty hogsheads of water. As a general rule we can say that more than three hundred pounds of water pass through a plant and are exhaled or transpired through its leaves for every pound of dry matter held by the plant. Young plants generally give off more water in this way than those which are older and more mature.

Kinds of Moisture: — Soils may be regarded as made up of a number of particles of different shapes and sizes thrown loosely together, with spaces between them. In dry soils these spaces are generally filled with air; but as the soil becomes moist or wet, the water drives the air out. Soil moisture may be classified as follows: (1) ground water; (2) capillary water; (3) hygroscopic water.

Ground Water. — The rain as it falls to the ground usually sinks through the soil until it reaches an impervious layer of hard pan or rock. At such depth it collects and forms what we call

ground water. It is also called the water table. In many parts of Florida the water table is within a foot of the surface. In other places it varies from a few feet to several hundred. When the ground water is near the surface it fills all the spaces of the soil; and as the air cannot enter the roots of the plants, they cannot grow and soon die. In many cases this can be remedied by proper drainage. Ground water serves its purpose better when it sinks below the surface of the soil about three or four feet.

Capillary Water. — We have frequently noticed that the oil passes upward through a lamp wick as fast as it burns in a lamp. When we examine the wick, we find that it contains a number of small spaces or pores connecting with one another. The oil passes from one space to another, and the force which causes it to rise is called capillary attraction or capillarity. Water will rise in the same way through the small spaces between the soil particles. In dry weather water rises from the moist soil below to supply the plants. If we leave a plank on the ground until the next day and pick it up again, we find that the lower surface is covered with moisture brought from the ground by capillarity. A loose blanket of plowed soil acts in the same way and serves as a trap to hold the moisture. From this we learn that frequent shallow plowing in dry weather is one of the best possible ways of saving soil moisture. This is a principle in "dry farming." Capillarity is feeble in sandy soils because its particles are so far apart. Many clay soils, on the other hand, are glutinous and the grains enlarge upon becoming wet and greatly retard the capillary movement. Capillarity works best in soils of medium texture.

Hygroscopic Water. — Every particle of dust, no matter how dry it appears, contains some moisture. Its presence can be detected by heating a small quantity of dry dust in a test tube to a temperature of 212° F. On allowing it to cool, drops of moisture will collect on the sides of the tube. The soil will suffer a loss in weight from 1 per cent to 10 per cent or more. Again, in some brick-making plants where hard pressed brick are manufactured, the dry clay is put in molds, and after being subjected to heavy pressure the clay comes out looking as damp as if it had been mixed with water, although not a drop of water is added to it at any time.

Uses of Soil Moisture. — We may mention four important pur-

poses which soil moisture serves: (1) dissolving plant foods; (2) transferring plant foods; (3) supplying plant food in itself; (4) regulating soil temperature and plant temperature.

Plant Food Solvent. — The mineral elements are dissolved out of the soil by water charged with carbon dioxide and humic acid and are made available for the use of the plant.

The Vehicle of Plant Foods. — The passage of liquids through a membrane is called *osmosis*, and it plays an important part in plant structure and plant growth. The soil water containing the soluble food elements is taken up through the membranes covering the roots of the plant and passes through the young wood of the plant upward to the leaves which manufacture the starch and sugar. These leaf-formed foods are then carried downward through the bark to all parts of the plant.

Water as a Source of Plant Food. — It is an easy matter to make many plants grow in water provided the water contains some nutrient salts, or the stored food in the cotyledons of the seedling is available. Hyacinths and narcissus bulbs may be made to bloom in water cultures. Beans, corn, wheat, or other grains, after sprouting, may be supported so that their roots are in water, and so long as the decaying seed or the water culture furnishes food, the plant grows. Water enters into combination with other compounds in the plant tissues, but pure water alone will not produce growth in plants.

Water as a Temperature Regulator. — **Moisture and Soil Temperature.** — The water from spring and summer rains is usually warmer than the soil and tends to raise the temperature, while that from winter rains is cooler than the soil and tends to lower the temperature. A dry soil is always warmer than a wet one. Many of the heat waves which fall on wet land are used up in evaporating its surplus water, while the heat waves on a dry soil are used to raise its temperature. The question of soil temperature is an important one to the farmer and should be studied closely. The lowest temperatures at which growth may be started, according to Ebermayer, is from 45° to 48°, but the best results are obtained at a temperature of 68° to 70°. The germination of wheat, rye, oats, and flax proceeds most rapidly at 77° to 87° F. and corn and pumpkins germinate best at 92° to 101° F. Corn that will germinate in three days at a temperature of 65.3° F. requires eleven days when

the soil temperature is as low as 51° . Oats that will germinate in two days at a temperature of 65.3° require seven days to make the same growth when the temperature is as low as 41° F.

We have already learned that the texture, slope of the land, and the color of the soil all have a marked influence on the temperature of the soil.

Depletion of Soil Moisture. — The store of soil moisture is depleted in three principal ways: (1) percolation, (2) evaporation, (3) transpiration.

Percolation. — The force of gravity tends to force the rain water downward when it reaches the earth. When the soil is coarse and full of gravel, this loss is considerable. Coarse soils should be rolled and made compact in order to hold the water near the surface.

Evaporation. — If we spill water on the floor of a room in summer time, it soon disappears. The same thing happens when we hang wet clothes on the clothes line. The water that disappears goes off in the form of vapor, and the process we call evaporation. Much of the moisture brought to the surface of the soil by capillarity is removed by evaporation. Sunshine, warmth, and wind all facilitate evaporation. Evaporation will also take place at freezing temperatures, but less rapidly. A dry, hot day soon removes the surface moisture of the soil and parches vegetation. In Nebraska, Kansas, and Texas hot winds have been known at times to dry up and kill all growing crops in two days' time. Fortunately such instances are rare.

Transpiration. — A great deal of water is removed from the soil and given off to the air through the leaves of the plant. The leaves correspond to the lungs of animals. This process of removing the water is called *transpiration*, and it varies greatly in different plants. Willows, poplars, cypress, and many other trees use up large quantities of water and are often used for drying out wet pastures. Transpiration is very rapid in warm, dry air and relatively slow in cool, moist air. It is more active in sunlight than in the shade, but it does not cease even at night. Evergreen plants transpire less than other kinds of trees. An oak tree seventy feet high and over eight feet in circumference has been found to transpire forty-four hundred pounds of water on a single summer's day. Such a tree, it is estimated, will transpire in the course of a single season

more than two hundred and fifty thousand pounds of water. The enormous amount of moisture transpired by trees has a very considerable influence in cooling the air in the vicinity of the leaves, for a great amount of heat must of course be used up wherever water or moisture is changed to the gaseous form. The temperature of a place may be perceptibly lowered by the evaporation of water from vegetation. This cooling influence is noticeable when one is passing a field of heavy green alfalfa.

Conservation of Soil Moisture. — When we consider the vast amount of water needed by plants, it is evident that every means possible must be practiced to conserve the moisture of the soil in hot, dry weather. The shallow surface of the soil should be stirred frequently. Widening the spaces between soil particles in plowed ground, checks the capillary action, so that less water reaches the top of the ground to be wasted by excessive evaporation. A mulch of humus or of manure will answer the same purpose. The water-holding power of different soils varies greatly. According to Johnson's investigations an acre of surface soil one foot deep may hold the following quantities of water:

Sand	1,197,900 lb.
Prairie Soil	1,524,600 lb.
Peat	2,047,300 lb.

Deep plowing at the proper time enables rain water to sink readily into the earth instead of running off to be wasted.

Irrigation. — In the western part of the United States the rainfall is so uncertain and scanty and the ground water is so far from the surface that there is rarely enough to supply crop needs. Fortunately many of these regions are traversed by river courses, and water is drawn off from these by means of numerous canals or ditches to the fields in cultivation. This process is called *irrigation*. Sometimes the supply of water is drawn from reservoirs fed by springs or artesian wells. The Salt River Valley and the Gila Valley of Arizona are rich farming districts made productive by means of irrigation. In Meade County, Kansas, the Pecos Valley in New Mexico, and in Redlands and other portions of California irrigation is often carried on from reservoirs fed by strong artesian wells.

Colorado, Idaho, Washington, and Nevada also have large irrigated sections within their borders.

The number of acres of irrigated lands in various countries is estimated as follows: India, 25,000,000; Egypt, 6,000,000; Italy,



An irrigation canal, California.

nearly 4,000,000; Spain, 500,000; France, 400,000. In the United States there are over 10,000,000 acres of irrigated lands, and there are many millions more that ought to be under irrigation. It is only a question of time when a large part of our so-called arid land will be irrigated, and these deserts will become the garden spots of the world.

EXERCISES

1. Place a drinking glass or tumbler over a small plant or flower and note results after a few hours. Explain.
2. Calculate the amount of water transpired or given off by thirty acres of grass land in a day's time.
3. Place a lamp wick or a piece of toweling so that one end rests in a bottle of water. Note results and explain.
4. Place some grains of corn in a bottle of lukewarm water and note results from day to day. Explain how the plant gets its nourishment.

5. Fill a tin can with coarse sand, another with clay, and a third with ordinary soil. Punch a number of holes in each can and pour water on each sample of material. Note the rate of flow accurately and record results. Explain.

6. Weigh a yard of cloth. Immerse the cloth in water, wring out the excess of water, and weigh again. Hang the cloth in the wind and weigh every ten minutes until the cloth is dry. Tabulate results and explain.

7. Place a weed or some other plant in a bottle of water having the roots well immersed. Stop the mouth of the bottle with cotton and weigh. After several hours weigh again. Note results and explain.

QUESTIONS

1. Discuss soil moisture.
2. Name the kinds of soil moisture.
3. Discuss ground water.
4. Describe capillary water.
5. Discuss hygroscopic moisture.
6. Mention four important purposes that moisture serves.
7. Discuss the necessity of a plant food solvent.
8. Discuss moisture as a vehicle of plant foods.
9. In what way is water a source of plant food?
10. Explain how water is a temperature regulator.
11. Name the ways in which soil moisture may be depleted.
12. Discuss percolation.
13. Discuss evaporation.
14. Describe transpiration and its effects.
15. Discuss the necessity of the preservation of soil moisture.
16. What is irrigation?
17. What can you say of the amount of irrigated lands in the world?

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X. DRAINAGE AND VENTILATION

Drainage. — Professor Shaler estimated that there are more than one hundred thousand square miles of swamp lands lying east of the 100th meridian which are the richest and most productive lands in the United States.

In this list might be mentioned the Great Dismal Swamp and the Florida Everglades. In these regions nothing but swamp vegetation will grow unless the lands have been drained to some extent. Farm crops will not grow on them for the following reasons: (1) the temperature is too low; (2) the soil ventilation is inadequate.

The advantages of good drainage cannot be overestimated. Some of its benefits are as follows:

1. It gives greater depth to the subsoil and hence gives the plant more room. But few plants raised by the farmer are hardy enough to force their roots into water-filled soils deprived of nearly every vestige of air.

2. Drainage warms the soil by admitting air to the soil and by lessening the amount of evaporation.

3. It increases the amount of plant food by favoring the growth of germs which prepare nitrates for the use of plants from the unavailable nitrogen of the soil.

4. It makes plowing possible earlier after rains and enables the farmer to begin his work earlier in the spring. This lengthens the growing season and produces more mature crops.

5. It improves the texture of the soil by making it loose and mellow.

6. It increases the porosity of the soil and enables the plant's roots to sink deeper into the rich and comparatively unleached soil.

7. It prevents the soil from being wasted by heavy washing after rains.

8. It fortifies plants against dry weather by enabling the roots of plants to go deeply into the soil where moisture can be found.

From our study of geography we have already learned that Holland owes its wealth and importance to its progressive engineers, who have successfully grappled with its drainage problems. The land is lower than the sea and ordinarily would be deluged with water, but thanks to the skill of its practical engineers, Holland is a country where, by dykes and ditches,



Windmills, Holland.

thousands of acres have been reclaimed, from the sea, and made to yield rich harvests. The Dutch first built walls or dykes around the low, swampy land and then pumped out the water by windmills into canals which carry the water away to the sea. Thousands of windmills as well as steam pumps are required to keep Holland dry.

Methods of Drainage. — The efficiency of various systems and kinds of drains is the first thing to be considered in the question of drainage. This will be determined largely by the free passage of water through them. Measured by this standard, tile drains seem to be the best and cheapest. Some of the reasons advanced for their use are as follows:

1. Durability. Good drains last for years and are always clear.
2. When properly laid, they are out of the reach of the cultivating tools of the farmer.
3. Cheapness. No other material suitable for this purpose can be found which is so cheap.

Where the land is level the drains should be gradually sloped towards the lowest portion of the land. The grade should be at least one foot in five hundred. The depth to which the water should be lowered by drainage need seldom exceed four feet, but it is governed by the character of the land. On light, open soils they should be deep, and on heavy land they should be near the surface. The

distance between the drains will vary with the closeness of the soil texture and the depth at which they are laid. Their distance apart varies from fifteen to one hundred feet. In Illinois, in rich black loam lands, the drains are usually from one hundred to one hundred and fifty feet apart. The size of the tile should not be smaller than three inches. Every drain should be placed on a true grade, and its outlet should end above the water line in order to prevent clogging by silt. The average cost of tiling in many places does not exceed \$11.50 per acre, while the productive value of the land will be nearly doubled.

Soil Ventilation. — The presence of air in the soil is just as necessary to the life of ordinary plants as water. In fact but few plants can flourish whenever the free oxygen of the air is excluded from them. It has been proved by experiments that seed will not germinate when oxygen is absent. If the soil is flooded, root breathing is checked and the plants are drowned just as effectively as an animal would be under water, because not enough free oxygen can reach them. Oxygen is needed in the soil by the germs which form the nitrates so essential to the plant. Likewise it is needed to prevent the destruction of the nitrates after they have once been formed.

Underventilated Soils. — When we examine soils of different kinds, we find that they vary greatly in their natural ventilation. Compact soils like clay are poorly ventilated, and in wet seasons water fills and chokes all their air spaces. Good drainage and proper tillage are the only available remedies suggested. We can easily prove the value of ventilation by planting a few garden seed in two samples of the same soil arranged as follows: In a tomato can of common soil place a few tomato or cabbage seed. Make a number of holes in the bottom of a second can, fill the can with soil, and plant seed as before. Keep the top soil loose in this can, but do not disturb the soil in the other can. Watch for several days and note developments. In a little while you will find that the plants in the first can have stopped growing. This is because the plant does not receive proper ventilation. Cultivation prevents the soil from baking and hardening and also helps to give it better ventilation.

Another thing which contributes towards soil ventilation is the

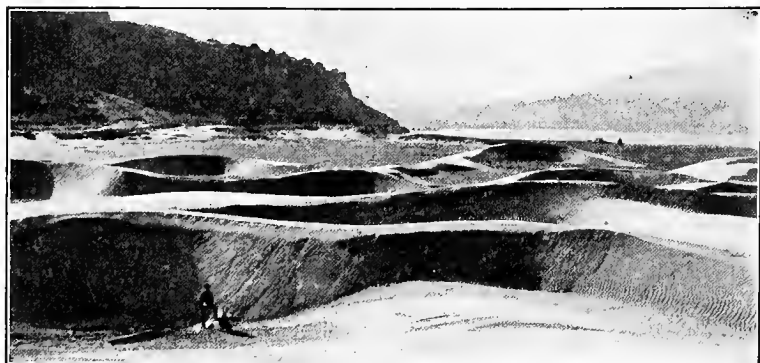
constant interchange of gases in the soil and the air above by the principle known as diffusion. The difference in temperature developed between the top soil and subsoils also assists in this process. Every change which takes place in the atmospheric pressure above a field has a tendency to cause some air to pass either into or out from the soil.

Under the influence of a heavy wind which comes in puffs, there is a tendency to alternately force such air out from the soil pores and again to allow it to return, thus producing an irregular but strong soil respiration. This is especially noticeable in Oklahoma, Texas, and some of the western States where there are high winds. As proof of this movement of the air we might call attention to the fact that in certain sections of the country which are underlaid by extensive beds of coarse gravel the wells sunk into these beds are often subject to strong draughts which alternately pass into and out of them. Prairies that are underlaid with layers of coarse gravel are usually very productive on account of the strong soil ventilation. It is claimed that in underdrained fields where lines of tile are placed three to four feet deep and from fifty to one hundred feet apart, there is provided a ventilation system which greatly facilitates the exchange of soil air.

Overventilation. — While some soils are underventilated, it frequently happens that other soils are so open that they are over-ventilated and the soil moisture is rapidly exhausted. Air and water both pass freely through this kind of soil and bear away nearly all the plant food. Such soils should receive shallow tillage and the undersoil should be kept firm. Applications of farmyard manure which tends to clog the pores of the soil will be found beneficial. Again, when the winds are unusually high, there is a heavy loss of the fine dust particles from light soils. This waste accumulates from day to day and soon impoverishes the soil, besides decreasing its water-holding power.

This destructive action of the wind is especially noticeable in arid and semiarid regions. In Wisconsin there are extensive areas of light lands where west or northwest winds after storms often sweep entirely away crops of grain, even after they are four or five inches high. In western Oklahoma, Texas, and Kansas similar conditions often exist.

Great injury is often done to the wheat crop by uncovering the roots and leaving them exposed. The only method of protection against winds is to set out groves, rows of hedge, and fringes of trees around every farm. In the Columbia River Valley the experiments conducted along this line have been very satisfactory and



Dunes.

successful, and demonstrate beyond question the advisability of providing suitable wind-breaks on open, exposed lands in windy regions.

In California and many other places drifting sands often accumulate and cover good soil and render it unfit for cultivation. The sand drifts like snow and forms ridges and mounds called dunes. The government has reclaimed some of these regions from waste by setting out sedges and wind-breaks.

EXERCISES

1. In the bottom of a tomato can make twelve holes, in a second make six holes, in the third make three holes; leave the bottom of a fourth intact. Fill the cans with warm, moist soil and plant the same kind of seed in each one. Note results from week to week and explain.

2. Repeat the experiment after driving holes into the side of each can. Explain results.

3. Repeat experiment one and place a layer of gravel or coarse sand in the bottom of each can. Note results.

4. Plant some seed in a glass vessel, an earthen jar, and a wooden box. Is there any difference in the growths? Why?

QUESTIONS

1. Estimate the amount of swamp land east of the 100th meridian in the United States.
2. Why is it impossible to grow ordinary crops on wet swampy lands?
3. How may such lands be reclaimed from waste?
4. Discuss the advantages of drainage.
5. Discuss methods of drainage.
6. What is meant by soil ventilation?
7. Discuss underventilated soils.
8. Discuss overventilation of soils.
9. What can you say of the damage done to crops by high winds in some of the western States?
10. What remedy is suggested for this danger?

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XI. TILLAGE

TILLAGE includes the usual farm operations of plowing, cultivating, harrowing, rolling, or any other stirring of the soil for the purpose of facilitating plant growth and improving the physical condition of the soil.

Kinds of Tillage. — Tillage which covers the entire ground we call open or general tillage, and when it covers only that part of the ground which lies between the plants we call it close or intertillage. Open tillage is used in preparing the ground for sowing seed; close tillage or intertillage is used in fruit plantations and growing crops. When the tillage extends more than six or seven inches into the ground, we speak of it as deep tillage. When it extends only three or four inches, we have what is known as shallow tillage. If the depth of the cultivation is less than three inches, we have what is called surface tillage.

Benefits and Advantages of Tillage. — 1. It destroys weeds. These as a rule are much stronger and more vigorous than most agricultural plants. If weeds are not destroyed while young, they deprive crops of food, water, and sunlight.

2. Tillage breaks and pulverizes the surface soil and makes it more absorptive and porous. Clods check and impede the growth of tender plants and afford such a narrow area from which to collect food and water that the plant soon withers away.

3. It preserves and regulates the soil moisture. Deep tillage provides a reservoir or storehouse of moisture, while shallow tillage checks evaporation and thereby preserves the soil water.

4. Tillage aerates and warms the soil. Plants set in ground that is not stirred and kept loose soon dwarf and present a sickly appearance. The ground bakes, and the soil moisture due to capillary action rapidly escapes and soon becomes exhausted. Tillage brings the soil constituents to the surface and helps to unlock unavailable plant food.

Methods of Tillage. — The universal method of tillage is with the plow. This important farm tool is found in every form and shape, from the Chinaman's wooden stick with its iron tip and the rude implements used by the uncivilized nations to the latest improved sulky cultivator or modern turning plow. The motive power varies in different countries. Sometimes the power is furnished by man, sometimes by means of horses and mules, and sometimes through the agency of steam or electricity.

In early times oxen were in general use, but to-day a yoke of oxen is almost a curiosity. On level lands the steam plow is



Steam plow.

growing more and more in favor. The greatest objection against the use of steam plows is the high cost of installment, which prevents farmers of only moderate means from purchasing them. Many of them, however, may be found in California, Kansas, Missouri, and some other wealthy farming States. The advantage claimed for the steam plow is that it is a great time saver and will do the work of ten men and thirty or forty horses. Many of these plows turn from eight to sixteen furrows at a round. It also enables us to plow to an increased depth, and in some cases it is possible to begin work before the land is dry enough to bear the trampling of horses. Wherever used they have been regarded as economical, effective, and expeditious.

EXERCISES

1. Make five seed plats and sow them in seed. After the plants come up cultivate No. 1 every day, No. 2 every other day, No. 3 every third day, and No. 4 every fourth day, but do not cultivate No. 5 at all. Note results and explain.

2. Plant some seed in cloddy ground, some in well-pulverized loose soil, and some in closely compacted and well-pulverized soil. Note results and explain.

3. How many acres of ground can a man plow with a breaking plow in a day? How many can he plow with a cultivator?

QUESTIONS

1. What is tillage?
2. Name the kinds of tillage.
3. Enumerate the benefits of tillage.
4. Discuss methods of tillage.
5. Compare the methods of tillage in different parts of the United States.

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XII. ORDINARY TOOLS AND IMPLEMENTS FOR SOIL PREPARATION

The Plow and Its Parts. — The plow may be best understood by considering its several parts.

a. The Beam is the horizontal piece of wood or steel by which the plow is drawn.

b. The Standard or Stock is the heavy piece of metal attached in a vertical position to the beam and to it many of the other parts of the plow are attached.

c. The Handles and Handle Bearers. These run from the lower part of the plow on a gentle slope to such a height that they may be easily held by the plowman. They are used for guiding the plow.

d. The Clevis is a piece of iron bent in the shape of a short but wide U. The two ends are perforated to receive a pin which passes through it and the end of the plowbeam to which it is attached. In the front part of the clevis are a number of holes for regulating the depth of the furrow. When the singletree or the doubletree is attached to the upper holes, the plow will run deep. When attached to the lower holes, it will run shallow. Sometimes there is a horizontal bar on the clevis also containing perforations.

e. The Plowshare is the V-shaped piece of metal which cuts the bottom of the furrow slice.

f. The Plowpoint is the sharp metal tip at the end of the plowshare which enters the ground first.

g. The Moldboard is the wide curved plate of metal above the plowshare which turns and throws the furrow slice.

h. The Colter is a revolving disk or a straight blade fastened to the beam just in front of the moldboard which cuts the furrow slice from the land. It is not always used.

Usually from two to three horses are hitched to heavy breaking plows. For light plowing after the soil has already been loosened a one-horse plow with small plowshare and narrow, thin mold-

board is used. In cultivating corn a small plow with two blades of shovel shape is often used. Sometimes these blades are called double shovels. Out of this has grown the modern cultivator, which carries four blades or plows, two being on each side of the row of plants cultivated. These blades are of several shapes and kinds, according to the cultivation desired.

Usually on the first plowing a thin tonguelike blade is used on each plow shaft. They are called bull tongues. In the second plowing the shovels are used, and on the third the diamond blades are used and the furrows thrown towards the plants. A wide piece of sheet metal is often attached to the cultivator in such a way that the furrow slice is prevented from covering up the plant. These are called fenders. These plowblades or shovels are attached to the plow shaft by an iron pin at the top hole of the plowblade and by a wooden pin at the lower hole of the blade bearing. In timbered countries this is necessary to prevent the shaft from being broken when roots or obstructions are encountered.

Surface-working Tools. — The plow does not usually leave the soil in proper condition for planting. Frequently the plowed surface is full of lumps and clods which must be pulverized before planting can be successfully undertaken. The objects of tillage are as follows: (1) to prepare a suitable bed in which sowing or planting may be undertaken; (2) to cover the seeds; (3) to reduce the soil to a proper degree of fineness; (4) to form a suitable mulch; (5) to destroy weeds.

Some of the principal surface-working tools are: the hoe, the rake, the cultivator, the rolling colter harrow, the spring-toothed harrow, and the colter-toothed harrow, etc.

Compacting Tools. — The compacting tools are drags, rollers, and plankers or floats. They serve the following purposes: (1) to pulverize the clods and lumps; (2) to level the ground; (3) to favor the germination of seed; (4) to render loose and open soils more compact; (5) to prepare the ground for the use of other tools.

Compacting reestablishes the capillary connection between the under soil and the air, but sacrifices the soil moisture at the surface, as it quickly evaporates. But in its passage upwards the soil moisture supplies the seeds with water and hastens germination.

Time for Plowing. — There seems to be a great difference of

opinion as to the best time for plowing, but in general we may say that it depends on the soil, climate, and crops. In many sections of the South it has been found that land broken in the spring is fully as productive as that broken during the fall. Clay soils should be broken in the fall or winter, especially in cold climates. Another argument in favor of it is that fall plowing lessens the great rush of spring work. In Texas, Kansas, Oklahoma, and Nebraska fall plowing is of inestimable value, as plowed land in arid or semiarid regions always contains more moisture. It is claimed that many insect pests are destroyed by fall plowing. January plowing is highly recommended in western Oklahoma and Texas as a means of eradicating the cutworms. Limestone soils and heavy grass sod demand fall or winter plowing to insure successful cultivation. Land in which alfalfa, rape, or turnip seed is to be planted should be broken in August if not sooner.

Depth for Plowing. — There is some difference of opinion as to the proper depth for plowing, but it is generally determined by the character of the soil, the season, the crop, and the amount of rainfall. Formerly farmers almost invariably advised deep plowing. Many still advise subsoiling to a depth of fifteen to eighteen inches, but recent experiments at the Experiment Stations in Georgia, Alabama, Mississippi, Missouri, Kansas, and Texas for different crops at different seasons of the year fail to show any advantage gained from it. In some cases the yield was not so great as was produced with ordinary plowing. The average depth in breaking for good results is from four to seven inches. In general, fall and summer plowing should be deep and spring plowing shallow. Semiarid and arid regions demand shallow plowing. Thin soils also should receive plowing at shallow depths. The depth of the plowing should be changed from year to year to prevent the formation of a hard pan layer which prevents the capillary movement of moisture from the subsoil. After planting, the farmer should see that the plowing is not deep enough to interfere with the growth of the roots of the plant.

Flat and Ridge Cultivation. — The relative merits of flat and ridge cultivation depend on the kind of crop, the nature of the land, the humidity of the soil, and the time of the year. Ridge cultivation is undoubtedly advisable on cold, wet clay soils because

evaporation goes on at a more rapid rate when more surface is exposed to the action of wind and sunshine, and because the trenches between the ridges drain off the surplus water. In the dry sandy regions of the West it is generally best to adopt flat cultivation. In many sections of the eastern and southern States ridge cultivation seems to give the best results.

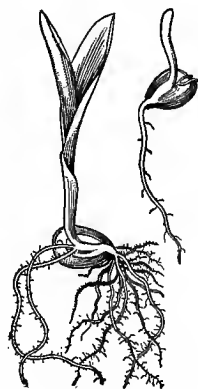
QUESTIONS

1. Discuss the beam of the plow.
2. What is the standard?
3. Describe the handle bearers.
4. Explain the workings of the clevis.
5. What is the plowshare?
6. What is the plowpoint?
7. Describe the moldboard.
8. Explain the use of the colter.
9. Name all the additional parts of a plow and explain the use of each.
10. Describe the sulky plow.
11. Discuss the parts of the cultivator.
12. Name the objects of tillage.
13. Name the surface working tools.
14. Name the compacting tools.
15. What are the uses of compacting tools?
16. Discuss the best time for plowing.
17. Discuss proper depth for plowing.
18. Compare relative merits of flat and ridge cultivation.

XIII. THE PLANT

THE plant is a living being, usually with many parts, called organs, which it utilizes for taking in nourishment, for breathing, for protection, and for reproduction. Every plant of the higher orders has three kinds of organs; namely, the root, the stem, and the leaf. The growth of the root is downward in the soil towards darkness and dampness, while that of the stem is upward towards light and air. The stem is the axis of the plant, and it is the part which bears all the other organs. The stem is the channel through which food prepared in the leaves passes to the roots.

The leaves in some respects correspond to the lungs in human beings, and through them the functions of respiration and transpiration are effected for the plant. In the air there is always present a certain amount of carbon dioxide, and when it comes in contact with the plant a portion of the carbon is taken up by the leaves, and the oxygen is left free in the atmosphere to be used by animals. They in turn contribute their share of carbon dioxide for the use of the plants.



Seedlings of corn
(after GRAY).

Besides this a great deal of carbon is returned to the air in the form of gas from fuels of different kinds while in a burning state. Millions upon millions of pounds of carbon are given back to the air every day by the numerous factories scattered all over the world. All the carbon in the plant comes from the carbon dioxide in the air. None comes through the roots from the soil. Carbon dioxide is taken up only by green plants and only in the presence of sunshine or other strong light. Carbon dioxide and water after coming in contact with the chlorophyll, or green substance, in the leaves are transformed into starch and sugar and other foods

necessary for the plant. The cells in all parts of the plant are nourished by this leaf-formed food and there are two currents to

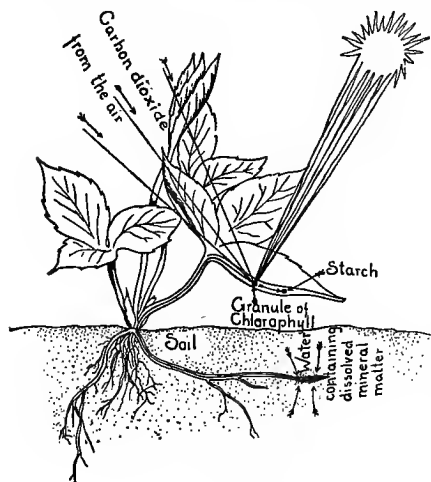
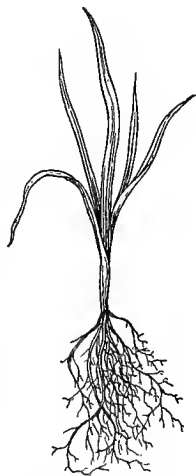


Diagram of the formation of starch.

carry it. One goes up from the roots through the soft sapwood to the leaves, and the other passes down through the bark with nourishment to the roots. In the center of a tree there is little or no sap movement, and hence all growth ceases there. If we girdle a tree, the downward movement of the sap is arrested, and no nourishment is carried to the roots. In a little while they cease to grow and fail to take in water in suffi-

cient amounts for the needs of the plant. As a result, the leaves wither and after a short time the plant dies. In transplanting trees we usually break and injure many of the roots so that an insufficient amount of water is absorbed and the leaves wilt and wither away.

If we sprout some oats in a germinator and examine them closely a few days later, we find many delicate hairlike appendages studding the surface of the larger roots. These small growths are called root hairs, and they are of great value to the plant. In some plants we often find as many as forty thousand of them on a single square inch. It is through these that the moisture of the soil is absorbed for the use of the plant instead of through the thick heavy roots. The activity of these root hairs or rootlets may be appreciated when we



Roots of oat plant.

consider the amount of sap dripping from sugar maples in the spring. It is also noticeable in the watery exudations of some plants after pruning in the spring; especially is this true of the grapevine, where this exudation continues for days and days after pruning. This pressure which forces the sap upward is called root pressure. It is also called osmotic pressure. Scientists have found that it is possible not only to measure the amount of water which the roots will raise in a given time, but also to measure the force exerted in the process of root pressure. In the case of the common nettle it is sufficient to support a column of water 15 feet high. With a common vine it will hold a column of water 36.5 feet high, and the birch will hold a column of water 84.7 feet high. This varies for different times of the day and for different seasons of the year. The grapevine shows its greatest pressure in the forenoon and decreases after noon. The sunflower reaches its maximum by 10 A.M. and then begins to decrease.

Offices or Functions of the Plant. — From an agricultural standpoint the plant has four principal uses or functions. 1. It aids in the formation and improvement of soils. 2. It modifies climate and environment. 3. It is the ultimate source of food for farm animals. 4. Plants furnish man with food and other useful materials.

General Classification of Plants. — Plants according to their duration of life may be divided into three classes: annuals, biennials, and perennials.

Annuals live and die within the year.

Biennials are plants that live for two years. They grow the first season without blossoming and lay up a stock of nourishment; they blossom and seed the next spring or summer. Turnips and beets are familiar examples.

Perennials are plants that live and blossom from year to year although some die down to the roots. Our common shrubs and trees may be taken as examples.

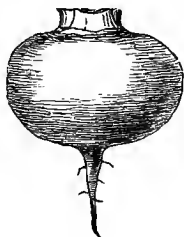
Classification of Crops. — When plants are grown in quantity, they and their products constitute a crop. The most important crops may be grouped in four or five classes:

1. *Cereal or Grain Crops*, including corn, wheat, oats, rye, barley, rice, etc.

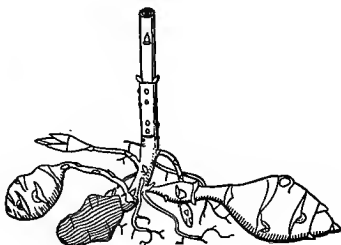
2. *Forage Crops*, grown for hay, fodder, or pasture, and including clovers and grasses.

3. *Root Crops* and those in which the root of a biennial plant becomes a storehouse of nourishment. Typical roots of this kind are turnips, beets, carrots, horseradish, etc.

4. *Tuber Crops*, the outgrowth of creeping subterranean stems growing beneath the surface of the soil or partly covered by it.



Turnip.



Jerusalem artichoke.

The best examples are seen in the potato, the Jerusalem artichoke, and the sweet potato.

5. *Fiber Crops*, including cotton, hemp, jute, ramie, Manila fiber, sisal, maguey, etc. Wool and silk are animal fibers and are discussed in Chapter XXI.

6. *Miscellaneous Crops* include those not described in the other classes.

EXERCISES

1. Let the students bring in plants and point out the vegetative organs.
2. Arrange to have one plant left with its roots exposed and note what takes place.
3. Place one plant in a glass or jar of water so that the roots will be covered and note how long the plant will live.
4. Invert one plant and immerse its leaves in water, but leave the roots exposed, and note the results.
5. Remove the roots entirely from one plant and place the stem in water. Note how much time elapses before the plant begins to wilt.
6. Compare the roots of the oat plant with those of the corn plant and note the chief differences.
7. If possible, bring in examples of each one of the leading classes or kinds of crops.
8. Make a list of all the crops grown in your county.

QUESTIONS

1. Discuss the plant in a general way.
2. Name the vegetative organs.
3. Discuss (a) the root, (b) the stem, (c) the leaf.
4. Discuss the sap movement.
5. Describe the root hairs.
6. Discuss the osmotic pressure of plants.
7. Give the three general classes of plants.
8. What are annuals?
9. Discuss biennials.
10. What are perennials?
11. Name the cereals.
12. Enumerate the forage crops.
13. Discuss the root crops.
14. Name the tuber crops.
15. Name the plant fiber crops.
16. Give two animal fiber crops.

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XIV. CEREALS OR GRAINS

Cereals. — As a rule cereal crops are grown for the grain or seed that they produce, but occasionally some of them, as corn and oats, are grown also for fodder. All cereals are annuals and have roots which grow in a cluster or crown. These branch out near the surface, but some roots penetrate to depths of three feet or more. The cereal crops grow on nearly any kind of soil, but they do best in moist clay loams which are well underdrained. The rich prairies of the United States and Europe are ideal soils for cereals.



Corn field.

Corn. — The great American cereal is maize or Indian corn. It is thought to be a native of tropical America, but the early settlers found it cultivated to some extent by various Indian tribes in the United States. Columbus found it cultivated on the island of Hayti, where it was called mahez, hence the name maize. It is now

grown in practically every State. The leading maize-producing States are Illinois, Iowa, Missouri, Indiana, Nebraska, Texas, Ohio, Kentucky, and Oklahoma. It is estimated that the entire production of the United States is nearly three billion bushels of corn, which is three fourths of the world's supply. Corn is a staple food for man and beast and furnishes the material for the manufacture of starch, glucose, and alcohol. Nearly every part of the plant is of commercial value.

The cobs are used for making corncob pipes, and this is an important manufacturing interest in Missouri and other States. The stalks are used for the manufacture of alcohol, oil, sirup,

and cellulose. The latter is used as an inside lining below the water line for our modern battleships and some steamships. The cellulose, when water strikes it, rapidly fills out and stops any ordinary opening made by shot and shell in the armor plate of the vessel. The blades and shucks afford valuable forage for stock if cut while green. A very good grade of paper and pasteboard can be made from the stalks.

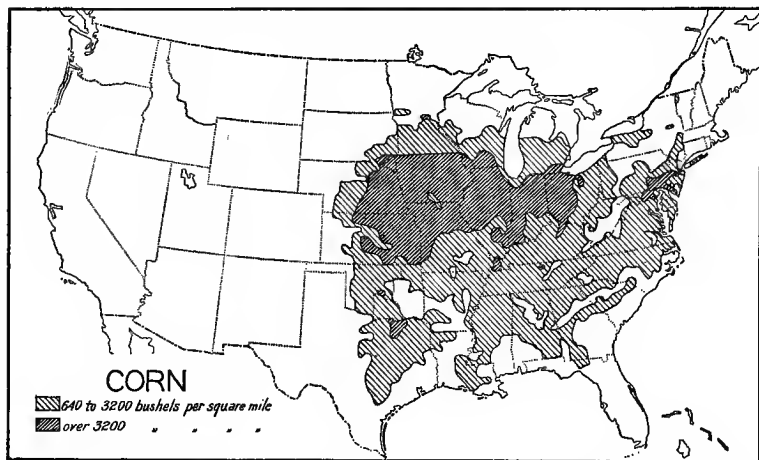
Kinds of Corn. — There are many varieties of corn, but the principal ones are known as pod corn, pop corn, soft corn, dent corn, sweet corn, and flint corn. The dent variety is very widely grown, and the yellow and white varieties are familiar to all. The pod corn is a peculiar type in which each grain is covered with a husk in addition to the outside cover-



United States.

Rest of world.

The world's corn crop

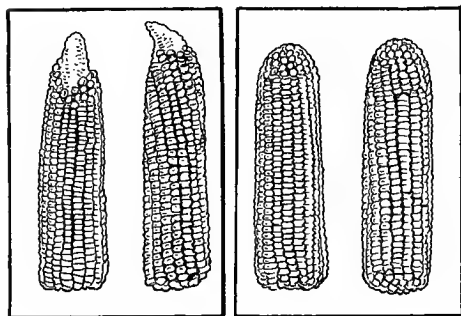


ing of the ear itself. It is thought to be the primitive type of all the other varieties.

Cultivation. — The ground should be broken as early in the season as the weather and soil will permit. In the West and South growing conditions are usually more favorable in the spring, as this

affords the young crop a chance to get its growth before the advent of the dry hot weather in the summer. The tillage should be as a rule moderately deep, but there is a great diversity of opinion on this point. The Southern Experiment Stations generally recommend that the plowing have a depth of five or six inches, while many of the Western and Northwestern Stations recommend a breaking depth from six to nine inches. After the plant begins to grow, shallow cultivation is always the rule everywhere, as deep plowing would injure the roots of the plant.

Selecting Seed. — To secure the best seed we must not wait until the corn is gathered, but we should go out into the field



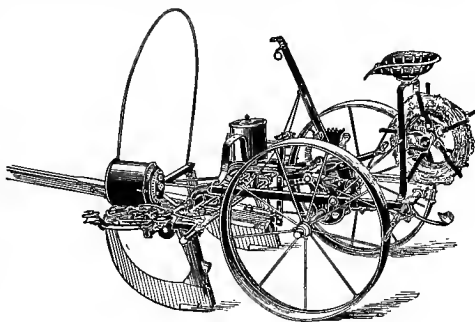
Improvement of corn by selection.

before the crop is gathered and select the most productive plants and take only the largest and most perfect ears. The stalk should be provided with plenty of leaves and should bear two or more good ears which point downward when ripe. The rows of grain should

be straight and the ear should be well filled out at both ends. Such a selection as this means considerable trouble, but it will pay for the time in the end. Do not overlook the time required for maturity in making your selections. It is also best to reject the grains at either end of the cob, since they are generally imperfect. See that all grains have clean, healthy looking kernels. Do not plant two varieties side by side, as they will mix and taint the purity of your crop, Pop corn and common yellow corn often mix when planted in adjoining fields. Plants soon become adapted to the climate, and locally grown seed carefully selected will in the end frequently give better results than any imported seed.

Method of Planting. — In pioneer days the field was laid off in furrows and cross furrows from 2½ to 3 feet apart each way, and the corn was dropped by hand, three or four grains to the hill, according to the judgment of the farmer. A little later the hand planter

superseded this. Still later came the corn planter with hand lever for dropping the corn, and finally this was followed by the modern check rower, in which the dropping or planting is accomplished by a check wire and check buttons which, by throwing levers alternately right and left, plant the corn at regular intervals. If the check wire is kept at the same tension, the rows will be perfectly straight and even.



Corn planter.

Sometimes corn is drilled to good advantage, but this method precludes cross cultivation and admits of plowing in only one direction. In many cases, however, this seems to give a larger yield.

Yields and Profit. — The yield varies in different parts of the country and the profits correspondingly. In the South the yield ranges from twelve to thirty bushels. In the river bottom districts of the Missouri and Mississippi rivers the yield often runs from fifty to ninety bushels to the acre. In other districts it runs from twenty to forty bushels. The average price is usually from 40 to 50 or 60 cents per bushel in good seasons. Good corn land rents at from \$3 to \$4 per acre. On this basis calculate the cost of raising an acre of corn, making due allowance for labor, time, seed, wear and tear on tools, etc., and estimate the profit. In some parts of the country corn is sold by the barrel, and in such cases we have only to bear in mind that five bushels of corn are required to make a barrel. It will be an excellent plan at this point of our work if the pupil will ascertain the different rules farmers have for measuring corn in bulk, whether in ricks or in pens.

Farmers usually in measuring corn take all the dimensions in feet and divide the product by 12 to ascertain the number of barrels, or by 2.4 to obtain the number of bushels. If all the dimensions are taken in inches, and the product divided by 2150.4 (cubic inches), the result will be in bushels.

The legal weight per bushel in many States is fifty-six pounds per bushel, but in some localities sixty pounds is the amount for shelled corn. For unshelled corn the legal weight varies from seventy to eighty pounds in different States according to the dryness of the corn.

Grading Corn. — According to Scofield the essential elements in grading maize are as follows: (1) the moisture; (2) the percentage of colors in mixtures; (3) the percentage of damaged grains; (4) the percentage of broken grains and dirt. The ordinary system of inspection for corn depends on soundness, plumpness, and mixture of foreign substances or of corn of different colors. In this case weight is not considered in determining the grade. The classes and grades as recognized by the Illinois Board of Railroad and Warehouse Commissioners are:

Yellow Maize, Numbers,	1, 2, 3.
White Maize, Numbers,	1, 2, 3.
Maize, Numbers,	1, 2, 3, and 4.

The rules for grading yellow maize are as follows:

No. 1. — Yellow maize shall be sound, dry, plump, and well cleaned.

No. 2. — Yellow maize shall be three fourths yellow, dry, reasonably clean, but not plump enough for No. 1.

No. 3. — Yellow maize shall be three fourths yellow, reasonably dry and reasonably clean, but not sufficiently sound for No. 2. The rules for white maize are the same as for yellow, except wherever we have the word three fourths in the above we read seven eighths.

Mixed maize or maize includes all maize that is less than three fourths yellow and less than seven eighths white. Yellow maize on the large markets is more abundant than white maize; and as might be expected, more mixed maize is dealt in than in both yellow and white combined.

Corn Judging. — This is a question that may frequently come up for discussion at Farmers' Institutes. There are a number of points to be considered in our tests on corn judging. The following are the points usually given in the ordinary score card:

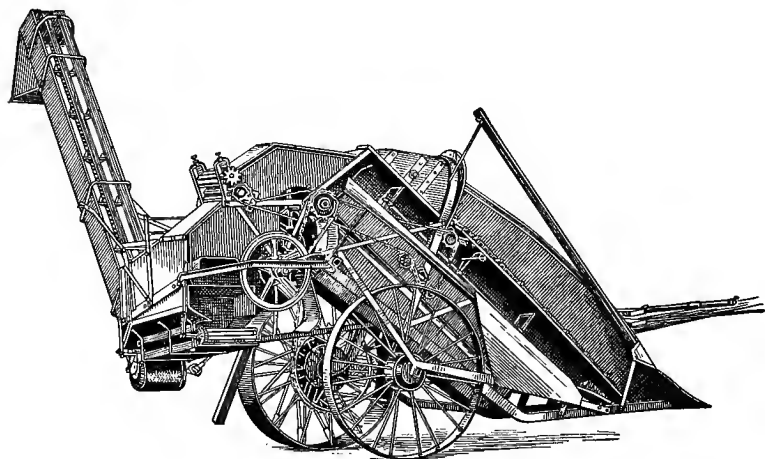
1. Trueness to Type or Breed, 10 points.
2. Shape of Ear, 10 points.
3. Purity $\left\{ \begin{array}{l} A. \text{ In Grain, 5 points.} \\ B. \text{ In Cob, 5 points.} \end{array} \right.$
4. Vitality or Seed Condition, 10 points.
5. Tips, 5 points.
6. Butts, 5 points.
7. Grains $\left\{ \begin{array}{l} A. \text{ Uniformity, 10 points.} \\ B. \text{ Shape, 5 points.} \end{array} \right.$
8. Length of Ear, 10 points.
9. Circumference of Ear, 5 points.
10. $\left\{ \begin{array}{l} A. \text{ Furrows between Rows, 5 points.} \\ B. \text{ Space between Tips of Grain at Cob, 5 points.} \end{array} \right.$
11. Proportion of Grain to Cob, 10 points.

Harvesting Corn. — The time and the manner of harvesting corn will depend on whether it is grown for the ears alone, for fodder, for both ears and stover, or for silage only. When grown for the grain the ears are left on the stalks until the corn is dry enough to be gathered and placed in the crib. This is generally about a month after the first severe frost or a few weeks after the corn has matured. Sometimes the corn is shucked as it is gathered, and sometimes it is left in the shuck, according to the pleasure of the farmer. A great deal of corn is now shelled in order to facilitate its shipment and its handling in the grain elevators. The old-time method of shelling corn by hand has now been supplanted by the patented corn shellers run by hand and by steam.

In the North Atlantic States and in some of the Central and Southern States a great deal of the growing corn is cut and put into shocks or into silos. A great deal of the cutting is done by hand with the old time corn knife, but in many places the patented corn cutter and corn harvester are coming into use. The combined corn binder and corn shocker is a new machine which is becoming very popular in some localities on account of the labor it saves. The corn picker and husker is another valuable labor-saving device which eliminates the disagreeable features of husking by hand.

The Corn Picker and Husker. — This machine picks and husks

the corn without cutting the stalks, which are left standing in the field. The ears are delivered into a wagon driven along the side of the machine so that the box is kept under the elevator. In either



Corn picker and husker.

light or heavy corn this machine will work successfully, and is designed for those who do not wish to cut or shred their corn crop.

Another valuable labor-saving device in preparing the corn-field for subsequent cultivation after the corn has been gathered is the stalk cutter, which by a system of horizontal revolving blades cuts all the stalks into small pieces in each row over which the machine passes.

Corn as a Food. — According to some authorities when stover is to be harvested it is best to have the plant as mature as possible without having the corn blades fall off while the corn is being shocked.

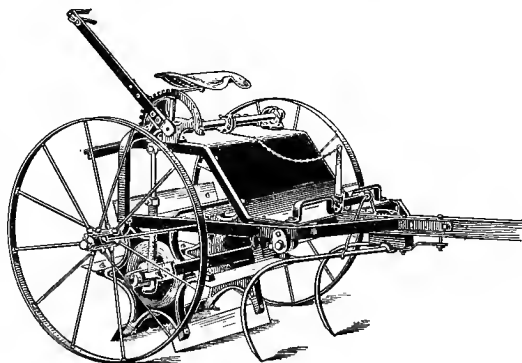
When the corn is desired for silage the unripened plant is cut into small pieces and placed in a silo, which is a receptacle with air-tight sides and bottom. The silo should be built of durable materials and should be from twenty-five to forty feet in depth, and the surface area should be such that the silage will be fed rapidly enough to prevent decay at the top. Generally a cubic foot of compact silage is a standard daily ration for a milch cow.

Corn, whether green or dry, is a palatable food for horses, cattle, and farm stock of all kinds.

Corn is also a valuable food for man and is prepared for his use in a number of ways. In the form of meal it is found in practically every farmhouse in the United States.

While the grain is in the milk, corn forms a palatable dish, especially when roasted or made into corn pudding. A great

deal of this kind of corn is canned and put up for winter use, and in many parts of the United States canning corn is an important industry. Other important food products derived from corn are grits, corn flakes, and hominy.



Stalk cutter.

QUESTIONS

1. What are the leading cereals of the United States?
2. Give a brief history of maize or Indian corn.
3. Mention some of the uses to which the various parts of the corn plant may be put.
4. Name and describe the various kinds of corn.
5. Describe briefly the cultivation of corn.
6. How should seed corn be selected?
7. Describe the method of planting.
8. Discuss the yields and profits of corn growing.
9. Discuss corn grading.
10. Discuss corn judging.
11. Discuss corn harvesting.
12. Mention some of the improved harvesting machines.
13. Describe the stalk cutter.
14. Discuss the value of corn as a food.
15. If corn is planted in rows four feet apart each way, calculate the number of hills in 40 acres.

16. Calculate the number of bushels of corn in a pen 6×6 feet and 10 feet high.

17. Take the dimensions of a wagon bed and calculate how much corn it will hold.

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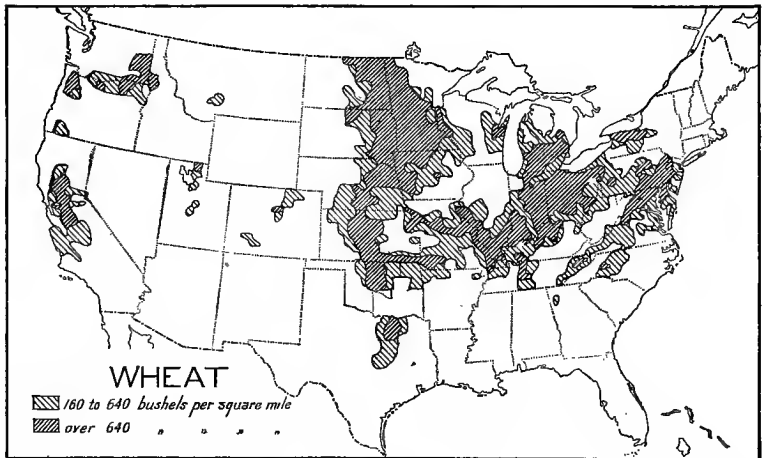
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XV. WHEAT

History. — So far as can be learned wheat was not grown in America before its discovery and settlement by Europeans. It is one of the oldest grain crops and one of the most useful. Many of the ancient monuments show that at the earliest time known wheat was the chief crop of Egypt and Palestine. (In the Bible it is everywhere called corn.) On the continent of Europe



it was cultivated by the lake dwellers of Switzerland as early as the Stone Age. The Chinese claim wheat as a native of their country and state that their people cultivated it as early as 2700 B.C. The Euphrates Valley in Asia is thought by many to have been the habitat of this grain in prehistoric times.

Production. — The ease with which wheat can be cultivated, its adaptation to a climate favorable to the beginning of civilization, and its quick and abundant supply of nutritious elements were reasons which no doubt caused primitive man to begin and continue its cultivation. It grows in a variety of soils and in both temperate

and warm climates. Clay loams seem best suited to wheat, and sandy soils seem to be the poorest, because the subsoil is apt to be too open. Wheat is raised in all parts of the United States and ranks third in the value of its crops. More wheat is raised in the United States than in any other country. The largest yield ever produced in a single year is about seven hundred and fifty million



bushels, or about one fifth of the production of the entire world. The great wheat belt extends through the corn belt northward into Minnesota, North Dakota, Montana, and the

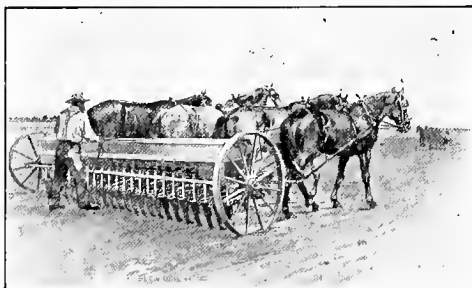
Great Northwest Territory of Canada. The center of wheat production is one hundred miles west of Des Moines, Iowa. The average yield of wheat in bushels per acre for Great Britain is estimated at 31.8, Germany 26, France 19.4, and the United States 13.4. In some parts of the United States, where climatic conditions are favorable and proper care is exercised in selecting the seed and in preparing the ground, a yield of forty bushels is not unusual.

Cultivation. — About three fifths of the wheat of the United States is usually planted in the fall. Wisconsin, Iowa, Kansas, Nebraska, Idaho, Washington, and Oregon produce both winter and spring wheat. Minnesota, North Dakota, South Dakota, Colorado, Utah, Montana, New Mexico, Wyoming, Nevada, Arizona, Maine, and Vermont raise spring wheat, while Oklahoma, Texas, Missouri, and the rest of the States raise winter wheat.

The soil should be well plowed, harrowed, rolled, and put in thorough condition before planting. The rolling is necessary to make the soil firm and compact so as to insure a moist under-soil. It also gives a firm foothold for the roots of the plant and brings up food and water for the use of the plant by capillary action. This favors germination and insures an early growth. Wheat in germination absorbs from five to six times its own weight of water, hence the necessity of a moist undersoil. The maximum and minimum temperatures at which wheat will germinate or sprout are given as 41° and 108° F., and the most favorable

temperature as 84° F. The temperature in the spring is still considered favorable when the range extends from 60 to 80°. The seed as a rule should not be over one or two years old. Saunders, in his experiments extending over a period of six years, found these results in vitality: Wheat one year old, 82 per cent; three years old, 77 per cent; four years old, 37 per cent; five years old, 15 per cent; six years old, 6 per cent. The depth of plowing in breaking the ground for wheat is, generally speaking, more than four inches and less than eight. Subsoiling has not been shown to be of any particular value.

As a rule from one to two inches is the most satisfactory depth for planting wheat, but this will vary with the kind of soil, the moisture, and the lay and the conditions of the seed bed. Sandy soils require deeper planting than clay soils. It is also advisable to sow deeper in dry soils than in wet soils. Gen-



A grain drill.

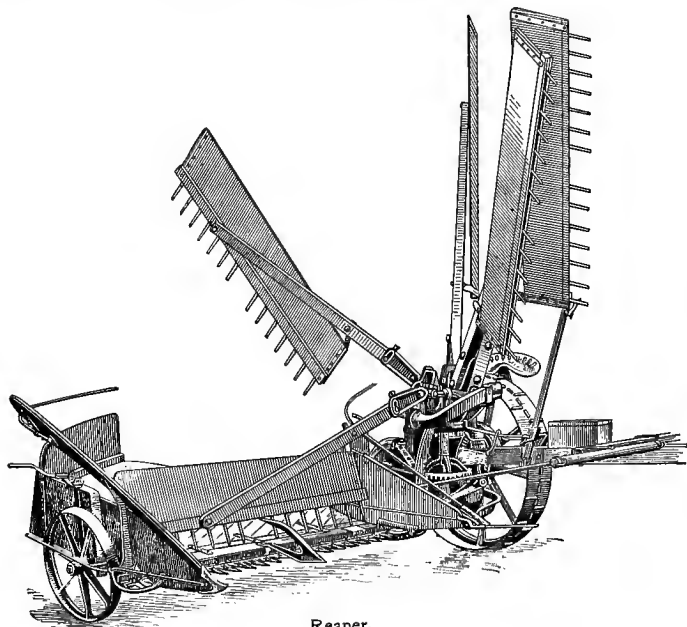
erally speaking, in sowing wheat, drilling is more satisfactory than broadcasting for the following reasons:

1. Drilling is more economical.
2. The seed is distributed uniformly.
3. It is sown at a more even depth.
4. The seed is placed in moist soil and rapid germination is insured.
5. It is protected against freezing, since the drill makes little furrows in which the snow collects and is kept from blowing away. This layer of snow prevents the wheat from freezing out.
6. The wheat is less likely to be heaved out from sudden freezing and thawing.
7. The seed is protected from heavy winds, which would blow away the soil and leave the seed bare if it were broadcast. In this case the soil drifts into the furrows and tends to deepen the covering.

Nearly all of the Federal and State Experiment Stations report that drilling increases the yield from two to eight bushels per acre. South Carolina and Iowa, however, report in favor of broadcasting.

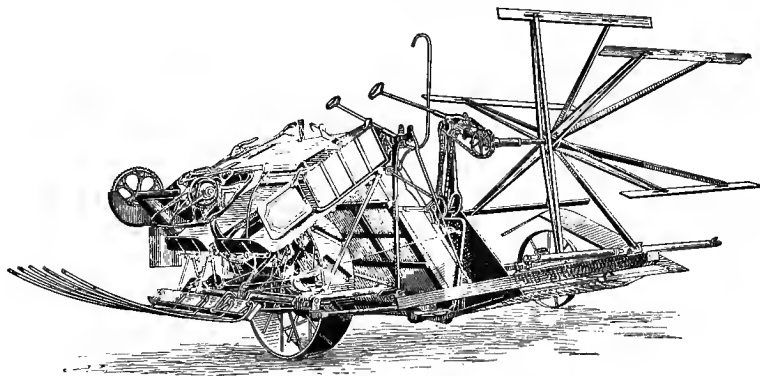
The quantity of seed to be sown per acre varies according to the

character of the soil, climate, time of seeding, and the conditions of the soil. Where the winters are severe, thicker seeding is needed



Reaper.

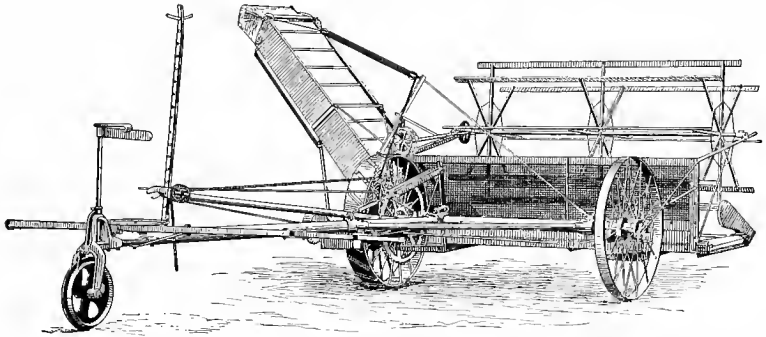
than where the winters are mild. In the Middle Atlantic States and in the Mississippi and Ohio valleys the amount needed is from



Binder.

seven to nine pecks. California reports in favor of three pecks for dry regions and five to eight in the more humid regions.

Harvesting. — When the wheat matures, it begins to take on a rich golden yellow hue. There is not a month in the year that



Header.

wheat does not mature in some part of the world. The wheat harvest of the United States begins with Texas in May and ends with the Dakotas in August. In California, which usually has a dry summer, the harvest begins about June 1 and lasts until the close



Harvesting wheat, California.

of July. There are five types of machinery for harvesting wheat: (1) the cradle; (2) the self-rake reaper; (3) the self-binder; (4) the header; and (5) the combined harvester and thrasher.

The header, instead of cutting the wheat near the ground, merely heads it, leaving the straw standing in the field; the header carries the heads of grain to the side of the machine and elevates



Combined harvester and thrasher.

them so that they are deposited in a wagon driven by the side of the machine. The grain is then hauled to the thrashing machine and thrashed. The header cuts a swath twelve to twenty feet



Harvesting wheat in France.

wide and averages twenty to thirty acres per day. The horses push the machine, instead of pulling it.

The combined harvester and thrasher is a combination of a header and a thrasher. This machine cuts a swath from eighteen to forty

feet wide, according to the power used. It cuts, thrashes, and sacks the grain all at one operation. Four men are required to

operate such a machine; one drives or guides, one tilts the cutter bar, and one sews up the filled sacks and dumps them on the ground, and one has general charge of the machine. It is used a great deal in California. In the central part of the United States the grain is usually cut by a self binder, shocked by hand, and later, after passing through the sweat, is ricked and finally thrashed by a steam thrasher.



Thrashing.

Varieties of Wheat. — The leading types of wheat are:

1. *Soft Winter Wheat*, found in eastern United States. Examples, Fultz and Harvest King.

2. *Hard Winter Wheat*, south of Minnesota and the Dakotas, between the Mississippi River and the Rocky Mountains. Examples, Turkey Red and Sibley's New Golden.

3. *Hard Spring Wheat*, in Minnesota, the Dakotas, northern Wisconsin, Iowa, and Nebraska. Examples, Fife and Blue Stem, and Macaroni Wheats.

4. *White Wheat*, in Pacific Coast and Rocky Mountain States. Examples, California Club, Sonora, Oregon Red Chaff, the Little Club, and the White Winter.

Grading, etc. — The standard, or legal, weight per bushel of wheat is generally sixty pounds, but the weight of a bushel by measure may range from fifty-five to sixty-five pounds. The rules for grading Red Winter Wheat are as follows:

No. 1 Red Winter Wheat shall be pure Red Winter Wheat of both light and dark colors of the shorter berried varieties, sound, plump, and well cleaned.

No. 2 Red Winter Wheat shall be Red Winter Wheat of both light and dark colors, sound, and reasonably clean.

No. 3 Red Winter Wheat shall include Red Winter Wheat not clean and plump enough for No. 2, but weighing not less than fifty-four pounds to the measured bushel.

No. 4 Red Winter Wheat shall include Red Winter Wheat, damp, musty, or from any cause so badly damaged as to render it unfit for No. 3.

QUESTIONS

1. Give a brief history of wheat.
2. Discuss the production of wheat.
3. Draw a map of the United States showing the wheat belts.
4. Discuss wheat cultivation.
5. Discuss harvesting, and harvesting machinery.
6. Name the leading varieties of wheat.
7. Discuss methods of grading wheat.
8. Ascertain the amount of wheat required to sow an acre of ground and calculate the amount required to sow forty acres.
9. Ascertain the average yield per acre for wheat in your locality, and calculate the value of forty acres of wheat at sixty cents per bushel and also at ninety cents.
10. Estimate the cost of sowing and growing an acre of wheat.
11. After deducting for the expense of thrashing and marketing, estimate the profit when wheat sells for ninety cents per bushel.

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XVI. OATS AND OTHER CEREAL CROPS

History. — Unlike wheat, the cultivation of oats was unknown to the ancient Hebrews, Greeks, and Romans. We have good grounds for believing that oats were cultivated in the east temperate portions of Europe and possibly in western Asia by the prehistoric inhabitants of those countries, but this in all probability was long after the appearance of wheat and barley. As civilization advanced the production of oats became more and more important. Oats stand third in acreage and value, but second in the number of bushels, in the cereals of the United States.

Yield per Acre. — In most of the Northern States forty to fifty bushels is about the average yield, although in many places sixty to seventy-five bushels is not unusual. In the South Atlantic division the yield is often less than ten bushels and rarely exceeds twenty bushels to the acre. The average annual yield for the whole United States is about twenty-eight bushels to the acre. It is a profitable crop clear to the seacoast in all the States bordering on the Gulf.

Varieties. — The winter varieties are grown principally south of the 37th parallel and the spring varieties north of that line as far as the 65th parallel, but seed have been known to mature as far north as Alaska.

Kinds of Soil Needed. — Almost any tillable soil will produce a fair crop under favorable climatic conditions if proper cultivation is given. Oats thrive best in moist cool climates like that of Scotland.

Cultivation. — Plowing for oats need not be so deep as for wheat and corn, but the seed bed should be put in thorough condition. Heavy rollers and other heavy compacting tools are to be avoided, but a light roller will be found beneficial if run over the ground either before the oats have come up or just after. Light harrowing is also beneficial, especially when a hard crust has formed on the ground.

Sowing broadcast is recommended by some Experiment Stations and drilling by others, but the majority of farmers seem to prefer the former method. The depth of sowing varies from one to four inches, but as a rule about two inches will be the proper depth. The winter sowing is usually during the period between



Harvesting oats.

October 1 and November 15, while the spring seeding takes place in January, February, and March according to location.

Grading. — The legal weight per bushel in nearly all the States is thirty-two pounds, except in Maryland, where it is twenty-six. In Idaho the average weight is thirty-six, and in Canada it is thirty-four. From this it will be seen that the weight decreases as we go southward. Elevator men frequently resort to what is known as clipping in order to increase the weight. The following classes and grades of oats are usually recognized by warehouse commissioners:

White Oats, Nos. 1, 2, 3, and 4.

White Clipped Oats, Nos. 1, 2, and 3.

Oats, Nos. 1, 2, 3, and 4.

No. 1 White Oats are white, sound, clean, and reasonably free from other grain. No. 2 White Oats are seven eighths white, sweet, reasonably clean, and reasonably free from other grain.

No. 3 White Oats are seven eighths white, but not sufficiently sound and clean for No. 2. No. 4 White Oats are seven eighths white, damp, badly damaged, musty, or for any other cause unfit for No. 3.

Barley and Rye. — Barley has been used as food for man and beast from time immemorial, and it continued to be our chief bread plant down to the sixteenth century. The culture of rye, on the other hand, is not so ancient, and we first hear of it on its introduction into the Roman Empire about the time of the Christian Era. Barley ranks fourth among the cereal crops of the United States, and it is one of the most valuable. For the last decade the relative values of our staple grains were as follows: Wheat, \$6.90 per acre; Oats, \$7.24; Maize, \$8.71; Barley, \$8.34; and Rye, \$5.95.

Barley is chiefly used as a food for domestic animals and for malting purposes, while the grain of rye is used for the production of flour, for food of domestic animals, and for the production of alcohol and alcoholic beverages. Rye straw is used to a large extent in the manufacture of paper, baskets, boxes, tables, trunks, fans, caps, and mats.

Rice. — Among all nations rice is held in high esteem. The Chinese have used it in some of their ceremonies since the year 2800 B.C. In their annual seed ceremony of sowing five kinds of seed, none but the emperor is permitted to sow the rice. Even in our own country the scattering of rice at a marriage ceremony is looked upon as a favorable omen.

The Saracen invaders introduced rice into Spain and Italy about the fifteenth century. It was introduced into the Virginia Colony in 1647, and into South Carolina in 1694 by the captain of a Madagascar trading vessel, who presented the governor with a bag of rice. Since then it has become one of the important crops of the Southern States, especially those along the Gulf of Mexico. The bulk of the rice crop of the United States is raised in Louisiana, South Carolina, Hawaii, Texas, Arkansas, the Philippines, Georgia, and North Carolina.



Rice.

Varieties. — There are no less than five types of rice, but they are usually classed under the heads, lowland rice and upland rice.



Rice field, Japan.

Upland rice may be grown upon any soil that is suitable for maize or cotton, and the method of cultivation is similar. Lowland rice



Rice field, Georgia.

must be grown on low ground, and water plays an important part in its cultivation. The rice is sown broadcast or drilled and covered not more than two inches. After planting water is turned on from irrigat-

ing ditches, and the ground is kept covered with water for several days until the seed begins to sprout; then it is drawn off until the plants get a good start, when the water is turned on again, and the ground is flooded every few days until the grain is ready to harvest.

Constant change of water is necessary to prevent stagnation. The rice should be covered from three to six inches with water. This flooding begins in June and is continued until August. At this time the water is drawn off, and in a few days the ground dries and becomes hard enough to hold up the heavy harvesting machines. Rice may be harvested with the self binder used for other grains and may be thrashed with the ordinary thrashing machines.

Grading. — The weight of a bushel of rice in the rough is forty-five pounds; and the average yield per acre is about thirty-five bushels in this country, but in Hawaii a yield of seventy-five or eighty bushels is not unusual. The New Orleans Board of Trade has established the following grades: extra fancy, fancy head, choice head, prime head, good head, fair head, ordinary, screenings, common, and inferior No. 2.

Sorghum. — It is supposed that this plant is a native of Africa. It has long been cultivated in southern Europe and China. It was introduced into the United States in 1757 by the Jesuits, who carried it to Louisiana. The Kaffir varieties were introduced about 1885 by the United States Department of Agriculture. These varieties are grown principally for forage and for their seed. About two hundred thousand acres of sorghum seed were grown in the United States according to the last census under the name of Kaffir corn. Nearly all of this was grown in Kansas, Oklahoma, Texas, and California. This did not include another variety usually called broom corn. Sorghum thrives where it is too cool and too dry for sugar cane.

Sorghum plants have a sweet juice in their cells, which is extracted by crushing and pressing. This is boiled down to form sirup or molasses. Many farmers in the Central Western States make their own sorghum sirup. The seed is sown broadcast frequently, but more often is drilled.

Sugar Cane is a tropical plant and, like sweet sorghum, is cultivated for the sweet juice stored up in the cell of its stalk. It is grown extensively in the South, especially in the States bordering on the Gulf. It is also grown extensively in Cuba and Hawaii. It requires a long time to mature and never ripens in any place that has frost. The period required is from twelve to eighteen months. Sugar cane is a perennial plant which reproduces itself

by cuttings containing eyes or buds. Two or more continuous lines of these are deposited in an open furrow and these are carefully covered with a cultivator. In a short time the cane sprouts and grows so vigorously that it soon fills the entire row. The kind of cultivation necessary is the same as that of ordinary maize or Indian corn. The rows should be from five to six feet apart.



Sugar cane plantation, Louisiana.

The one planting of cane generally gives two crops. The first is called plant cane and the second ratoon or first-year stubble. Cane will come up every year from the stubble of the preceding crop for fifteen to twenty years, but each succeeding crop grows smaller and smaller, so that it is not good policy to follow such a plan.

Sirup and Sirup Making. — For making sirup the only apparatus needed is a crushing mill and an evaporating pan or kettle. All that is necessary is careful boiling, constant skimming, and careful straining. In the large sugar mills vacuum pans, clarifiers, centrifugal or whirling machines, pumps, filter presses, and much expensive machinery will be found. When sugar is to be made, the sirup is drawn into a vacuum pan where, after being cooked for some time at a high vacuum, a mixture of sugar and molasses results. This is transferred to a centrifugal machine with sides

of gauze. By rapid rotation of the containing vessel, the sirup is thrown through the gauze into an outer vessel, while the sugar remains in the inner containing vessel.

Yields. — In the United States cane usually produces from fifteen to forty tons, in Java forty tons, and Hawaii sixty to one hundred and twenty tons to the acre. A ton of Louisiana cane in the



Cutting sugar cane, Porto Rico.

refinery will make about one hundred and fifty to two hundred pounds of sugar, and about three gallons of low-grade molasses. Many planters devote all their energies to manufacturing sirup and realize from three hundred to six hundred gallons of sirup to the acre.

QUESTIONS

1. Give a brief history of oats.
2. What is the average yield of this crop?
3. Name the leading varieties of oats.
4. What kind of soil is best suited to this crop?
5. Discuss the cultivation of oats.
6. Describe the system of grading of this grain.
7. Discuss the value of barley and rye.
8. Give a brief history of rice.

9. Discuss its cultivation.
10. Describe the plan of grading rice.
11. Give a brief history of sorghum.
12. Discuss the growing of sugar cane.
13. Discuss sirup and sirup making.
14. What can you say of the yields of sugar cane?
15. Calculate the value of forty acres of oats at sixty bushels to the acre when oats are worth thirty-five cents per bushel.
16. Compare the value of the oats in problem 15 with the value of forty acres of corn at fifty bushels to the acre when corn is worth forty cents per bushel.
17. Compare these values with average production and average values in your own locality on forty acres.

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XVII. FORAGE CROPS

WE have already learned that crops grown for hay or pasture are called forage crops. If the crop is gathered and fed before ripening, it is called green fodder; if it is cut and cured or dried before feeding, it is called dry fodder. Forage crops may be divided into the following classes:

1. The perennial grasses, such as timothy, red top, Kentucky blue grass, orchard grass, Bermuda grass, etc.

2. The annual forage plants, such as foxtail millet, broom-corn millet, pearl millet, etc.

3. Leguminous plants, including clover, alsike, white clover, alfalfa, bur clover, Japan clover, vetches, velvet bean, field bean, field peas, peanuts, cowpeas, soy beans, etc.

Green Feed. — 1. *Pastures.* Any field on which animals graze is called a pasture. Pastures are divided into two classes, permanent and temporary.

2. *Temporary Pasture.* — A temporary pasture is a field containing some crop intended to furnish temporary grazing. Wheat, oats, rye, barley, are often sowed for this purpose. Annuals, biennials, and perennials serve this purpose equally well.

3. *Permanent Pastures.* — Permanent pastures are fields on which perennial crops are planted and grown year after year.

One of the best perennial crops is the Kentucky blue grass, which reaches its best development in the region between the Appalachian Mountains and the Mississippi River. It does not grow well in dry climates or on sandy soils. Moist climates seem to suit it best. It makes a compact sod and is unexcelled for lawns and ornamental purposes. Its greatest fault lies in the fact that it fails to supply a desirable pasture through the heated period in July and August.

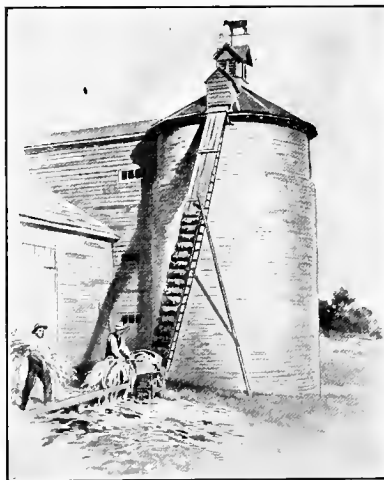
Bermuda Grass. — The principal pasture plant of the cotton States is Bermuda grass, which is highly nutritious and is very productive. It seems well adapted to the semiarid regions of the West and also grows well in the sandy soils of Florida and other

States. Under favorable conditions it will yield from two to four tons of hay to the acre, and may be cut two or more times during the same season.



On a blue grass stock farm.

Red top. — This grass forms a sod very quickly and generally produces an abundance of pasturage. It is less palatable, however,



Silo.

than many of the other varieties used for pasturage. It thrives under a wide range of both soil and climate.

Other Forms of Green Feed. —

Besides the pasture forms of green feed we have two others known as soiling and silage, which should be considered at this point.

Soiling. — When crops are cut and fed while green, the process is called soiling, and such crops are known as soiling crops. Maize and Kaffir are often fed in this way.

Silage consists of green crops stored in pits or in air-tight rooms above the ground. This compartment in which the food is stored is called a silo.

All crops may be used for making silage, but green corn is the one generally used. Silos above ground may be built of stone, concrete, brick, or other material. When wood is used, the wall may be of upright studding with an airtight lining, or of staves bound together with hoops. Silage is excellent for milch cows, and every farmer should have a supply for them. The Romans and some of the early Europeans were familiar with the uses of silage over two thousand years ago. In this country it has been known since 1875.

The Annual Forage Plants. — Plants of this class produce a strong vigorous growth and mature during the course of a single year. Many of the cereals furnish by-products that can be utilized as forage. Corn and oats are both often planted for this purpose. The stalks and blades of the corn together with the shucks make good feed for stock whether fed green or dry. In using this kind of forage it is not advisable to permit cattle to pick over stalks that hogs have been running over and trampling under their feet as it is likely to cause disease. When corn is used for this fodder, the stalks are cut shortly before they mature and are placed in shocks fifteen to twenty feet apart. Oats when used as a forage may be pastured while green like ordinary grass or they may be cut after maturity, and put in shocks or ricks as may suit the fancy of the farmer, and later may be fed to the stock at his convenience. In this form they are known as sheaf oats. In addition to the cereals the next most important annual forage plants are the various kinds of millet grown in this country. It is estimated that millets comprise less than 5 per cent of our supply of hay and forage. Sorghum and Kaffir corn are also grown extensively as forage.

Millets. — The farmers in Kansas, Iowa, Missouri, and Nebraska grow a great deal of millet. It has also been successfully grown in Oklahoma, Illinois, Texas, the Dakotas, and in Michigan. Recent experiments and observations indicate that millets may be profitably grown in many of the Southern States. The millets known in this country may be roughly grouped as follows: (1) broom-corn millet, (2) foxtail millet, (3) barnyard millet, (4) pearl millet.

Millets may be regarded as a kind of coarse annual grass, very

palatable and nutritious when fed to domestic animals under proper conditions. When millet is permitted to mature, it is too coarse and woody to be relished or digested. The sowing is done in May, June, or July according to the beginning of the warm season in the various parts of our country. The amount of seed sown to the acre varies from one to three pecks. Millets, on account of their rapid growth and ability to resist drought, are frequently sown in hot weather for the purpose of subduing and choking out weeds.

Leguminous Plants. — The legumes include a large number of plants and are so called because their seeds grow in pods or legumes.



Root of soy bean,
with nodules.

These plants are of great value because they fertilize and enrich the soil besides furnishing excellent forage crops. They send their roots deep into the soil and bring up a rich supply of mineral constituents that cannot be reached by ordinary plants. They also take up a great deal of nitrogen from the air, which is added to the soil on the maturity of the plants and the soil is enriched to that extent. The leguminous forage plants include the clovers, alfalfa, the vetches, cowpeas, soy bean, peanut, the velvet bean, and others.

Nitrifying Bacteria. — Leguminous plants contain a large amount of proteid and take up free nitrogen through minute organisms which establish themselves in small nodules or tubercles found on the roots of these plants. These tubercles may be round, oval, pear-shaped or very irregular, and may vary in size from six hundredths to three tenths of an inch. The organisms which occupy these tubercles are microscopic plants known as bacteria. Slight differences are found in the bacteria associated with the various kinds of legumes, and in a few cases one form of tubercle bacteria can adapt itself to some other plant as a host. It is thought that in time we may be able to develop these bacteria artificially without the agency of the legumes and apply them to the soil in such a way that it would be enriched with nitrogen through their presence, even when the plants grown on the soil were not leguminous plants or their allied families. The United States

Department of Agriculture at Washington has already conducted a number of successful experiments along this line. The introduction of these bacteria into the soil or plant is usually styled inoculation.

Methods of Inoculation. — In general there are three ways of inoculating the soil:

1. By growing the same plant until the bacteria formerly present in the soil adapt themselves to the host.

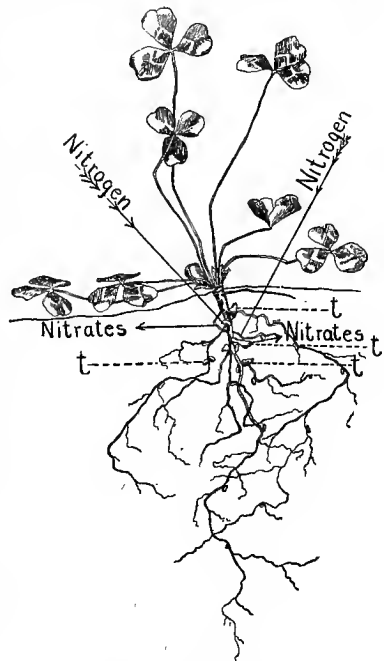
2. By adding artificial cultures of the proper form of bacteria. The Department of Agriculture at Washington is now distributing liquid cultures in small hermetically sealed tubes to farmers, with full instructions for increasing and applying the bacteria.

3. The third method is the direct application of soil from a field rich in nitrogen-bearing bacteria at the rate of one hundred pounds or more to the acre.

A few days before planting, the fresh bacteria-laden earth should be scattered over the field and immediately harrowed into the soil. Another method is to flood the field, when possible, with water strongly inoculated with the bacteria.

The Clovers. — This group of plants comprises a large number of species, variously estimated from one hundred and fifty to three hundred; but the varieties most generally known are: crimson clover (annual); red clover (biennial); Alsike or Swedish clover (triennial); white clover (perennial).

Clovers are profitable crops for forage purposes and at the same time are valuable as soil improvers, because they enrich the soil



Tubercles on clover roots.

with humus and nitrogen, while their long penetrating roots loosen up the soil and improve its physical character.

Crimson Clover has come into general notice in this country only since 1890, but it is said to have been cultivated in very early times near the Pyrenees Mountains in north Spain and France. It is grown in the South Atlantic States north of the cotton belt on sandy, loose soils. It is valued chiefly as a cover crop or for soiling.

Red Clover. — This useful crop is said to have been first cultivated in Persia, and was brought during the fifteenth century to Spain and Italy, thence to Holland, and in 1633 was carried from there to England. Its first appearance in this country was in Pennsylvania about 1770. Red clover may be found growing in the United States east of the 100th meridian and north of the 35th parallel of latitude. It is also grown to some extent in Washington and Oregon along the Pacific coast. Red clover may be sown at different times of the year according to the climate and season, but good results are usually obtained from early spring sowing. Many farmers favor fall sowing, especially when wheat and clover are sown together. Under favorable conditions red clover will yield two crops a year, but the second crop is not always satisfactory for feeding purposes, on account of its unfavorable effect on stock. On account of the high price paid for clover seed many farmers thrash their crop and sell the seed. The legal weight is usually about sixty pounds to the bushel.

Alsike or Swedish Clover gets its name from the village of Alsike, in Sweden, where it was first cultivated. From there it was carried about 1834 to England, and later it was brought to America.

Alsike clover closely resembles white clover, but the flower heads are slightly larger and have a decided pink color. It is grown for pasture and also for hay. It thrives in many soils and climates where red clover produces an unsatisfactory growth. Sixty pounds is the usually accepted weight for a bushel of the seed, but a bushel by measurement will generally run from eighty to ninety.

White Clover grows well throughout the United States in moist and well-drained soils. It is much used for pasturage, but in the months of July and August horses grazing on it often slobber excessively on account of the acrid nature of the seed. White

clover is often sown on lawns with blue grass. It is also often sown for the benefit of bees, which draw upon it as a honey plant.

Alfalfa. — The value of alfalfa for hay and forage purposes has been known from very early times. It was introduced into Greece about 476 B.C. from Media and was afterwards grown extensively by the Greeks and Romans. Alfalfa is adapted to a warm climate, but is grown over a wide area in the United States. It grows better in soils that are alkaline than in those that are acid. Its roots penetrate to great depths and thus enable the plant to resist the blighting influences of ordinary dry weather and prolonged droughts. It is not an uncommon thing to find the roots descending from ten to twenty feet in the ground, and cases have been known where alfalfa roots have been found at a depth of more than fifty feet.

Before alfalfa is sown the ground must be properly prepared. The ground should be plowed deep and should be well drained and well ventilated.

Fifteen to thirty pounds of seed are sown to the acre. Alfalfa may be sown any time during the year from April to October, according to the climate, season, and location. Farmers in the Northern States usually do their sowing in the spring. From three to five cuttings may be made, according to the season and state of the weather. This fact makes alfalfa one of the most valuable crops that a farmer can raise. It takes up nitrogen from the air and at the same time enriches the soil by bringing up vast stores of plant food from the depths of the earth to the surface of the soil. Alfalfa makes splendid pasturage for horses and hogs, but is not so satisfactory for cattle and sheep unless mixed with dry roughage. Alfalfa does not reach its prime until the third or fourth year after planting. The first sowing usually keeps the soil stocked for ten to fifteen years without further sowing.

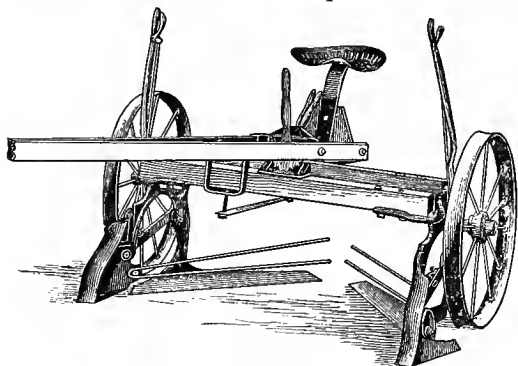
Vetches. — There are some fifteen or twenty kinds of vetch, but only two are grown in this country to any great extent. These are the spring vetch, widely used as a soiling crop in England, and the winter vetch, which is grown for hay in Washington, Oregon, California, and in some of the New England States. The latter is a winter annual with trailing stems which grow from three to nine inches in length.

It bears bluish purple flowers which produce pods filled with about six brown or brownish black seeds. Winter vetch has been found especially valuable in the improvement of poor, sandy, and gravelly soils. It may be sown in the spring, but the most satisfactory results are obtained when it is sown in the fall. This is a crop that our farmers should learn more about.

Cowpeas. — The cultivation of cowpeas was carried on at an early age by the Orientals, who used them not only as a forage crop but also as an article of diet. The cowpea is one of the principal forage crops in the South Atlantic and South Central States. Under favorable conditions they have been grown as far north as Wisconsin and the New England States. The cowpea is a strong feeding annual which adapts itself readily to any ordinary soil and climate. It grows on thin poor soil where other crops make a failure, and is a valuable soil improver, especially when the plants are plowed under while green. The time of seeding varies according to the climate, but in the Southern States, June, July, and August are considered the best months. The amount of seed sown varies from a peck to three or more bushels. Experiments seem to indicate that drill-

ing is the most satisfactory method of planting. It is also frequently found advisable to sow cowpeas with some other crop, especially millet or sorghum.

The **Soy Bean**, or soja bean, is a native of China and Japan, but it grows well in the United States,



Bean Harvester.

especially in the States of the corn belt region. Like the cowpea, it is a great soil renovator, and is much used by some farmers for this purpose. This plant is remarkable for the large and abundant tubercles found upon its roots. It is a hardy, upright annual, growing usually to the height of three feet or more. It bears violet-tinted flowers, which are small and inconspicuous. Later

these produce pods which contain the seed. In planting the seed should be drilled so that the drill rows will be thirty to thirty-six inches apart. The amount of seed sown varies from a peck to one third of a bushel per acre. In harvesting the seed the work may be done by hand, but this is slow and expensive. When large crops are raised, the bean harvester is generally used.

The harvester, which is mounted on wheels, is fitted with rods on rolling dividers so that the vines are gathered two rows at a time and brought together at the rear end of the machine in a windrow, the plants being almost entirely free from roots and dust. The roots are severed by two knives which are set in a V-shaped position, and adjusted by levers in such a manner that they can be set to run just below the surface. In harvesting the crop these knives not only sever the plant from the root, but in passing beneath the surface they also stir the soil and leave it in an excellent condition for wheat. Planting the beans in rows thirty to thirty-six inches apart facilitates harvesting where one of these machines is used.

Soy beans may be frequently sown after other crops have matured and a fair yield be obtained. In Oklahoma and in a few other States it has been grown successfully on the same ground after the wheat crop has been removed.

A study of the following table taken from Bulletin No. 74 of the Oklahoma Experiment Station will be of interest:

"TABLE I. THE COMPOSITION OF COWPEAS AND SOY BEANS IN COMPARISON WITH OTHER FEEDS

FEEDING STUFFS	WATER	ASH	PROTEIN	CRUDE FIBER	NIT. FREE EX.	ETHER EX.
Soy Bean seed	10.8	4.7	34.0	4.8	28.8	16.9
Cowpea seed	14.8	3.2	20.8	4.1	55.7	1.4
Cotton seed	10.3	3.5	18.4	23.2	24.7	19.9
Indian Corn — grain .	10.6	1.5	10.3	2.2	70.4	5.0
Soy Bean hay	11.3	7.2	15.4	22.3	38.6	5.2
Cowpea hay	10.7	7.5	16.6	20.1	42.2	2.2
Alfalfa hay	8.4	7.4	14.3	25.0	42.7	2.2
Indian Corn stover . .	40.5	3.4	3.8	19.7	31.5	1.1

“In this table sufficient data are submitted to enable one to make a threefold comparison. First, cowpea seed and soy bean seed are compared with Indian corn grain and cotton seed, and the conclusion is self-evident that these grains are appreciably richer in ash and protein than the grain obtained from the Indian corn plant. The soy bean contains a high percentage of fat, and a comparatively low percentage of the nitrogen free extract, while with Indian corn the reverse is the case. The soy bean stands in advance of the cowpea notably in fat and protein. It is also clear that the grain produced by these legumes compares very favorably with cotton seed. The figures also indicate that soy bean and cowpea hay are slightly superior to alfalfa from the standpoint of composition, while corn fodder is decidedly inferior to any of these legumes. The mixing of soy bean hay with corn fodder during the ensiling process would appear to be a good practice, since an improved product is the result.”

The Velvet Bean is a native of India, which was originally introduced into the United States as an ornamental garden plant in the nineteenth century. The velvet bean is a large tropical plant that produces vines thirty to fifty feet in length. It bears purple flowers which produce pods covered with a dark velvety down and from three to six seeds are found in each pod. It grows well in the cotton States on light sandy soils. The growth of the plant is greatly increased when potash and acid phosphates are added to the soil. It yields generally twenty to thirty bushels of seed and from two to four tons of hay.

The Florida Beggar Weed is an annual which grows on rich, moist, sandy lands of Florida and the Gulf States. It is readily eaten by stock and makes very good pasturage. It also furnishes very satisfactory feed when cut and used as hay.

The Peanut is a trailing annual plant which grows from one to two feet high and matures its fruit underground. It is valuable as food when roasted, and it is also used in making candy, oil, and peanut butter. Some varieties, like the Spanish peanut, are grown for hay and prove to be very satisfactory feed for stock. This variety is said to be an ideal hog food, and an acre of it will produce from three to five times as many pounds of flesh on a hog as the ordinary Indian corn. The seeds are planted in

hills by hand from eight to twelve inches apart, or they may be drilled in rows, sometime in May. The crop matures early and should be harvested before frost in the fall. Peanuts are grown in many parts of the United States, but they are produced mostly in Alabama, Arkansas, Oklahoma, Tennessee, Virginia, and the South Atlantic States.

QUESTIONS

1. Name the classes of forage crops and give examples.
2. Define (a) pasture, (b) temporary pasture, (c) permanent pasture.
3. Discuss (a) Kentucky blue grass, (b) Bermuda grass, (c) redtop grass.
4. What is meant by soiling crops?
5. Discuss silage.
6. Discuss the annual forage plants.
7. Describe the various kinds of millets.
8. Discuss the legumes.
9. Describe the three methods of inoculating legumes.
10. Name the clovers.
11. Describe (a) crimson clover, (b) red clover, (c) Alsike clover, (d) white clover.
12. Discuss alfalfa.
13. Discuss the cultivation of cowpeas.
14. Describe the cultivation of the soy bean.
15. Which kind of forage crop enriches the soil the most?
16. How does the soy bean compare with Indian corn in the amount of nitrogen it contains? Compare both as to the amount of protein.
17. Calculate the relative amounts of water, protein, and nitrogen in one hundred and seventy-five pounds of corn and one hundred and seventy-five pounds of cowpeas.

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XVIII. ROOT CROPS AND THE TURNIP FAMILY

THERE are several kinds of plants whose roots and thickened stems have been found valuable as food. They may be placed in about four groups: The first group includes garden beets, sugar beets, and mangel-wurzels; the second embraces turnips, rutabagas, kohl-rabi, cabbage, rape, and kale; the third includes the carrot, and allied forms; and the fourth embraces the parsnip, etc.

The Beet. — The beet is strictly speaking a modified stem and primary root, the latter being really a continuation of the former. The main root is covered with a number of fine hairlike rootlets which drink in the nourishment and moisture from the soil. Beets grow best in a moist climate, but when properly irrigated they have also been successfully grown in dry regions. In addition to the ordinary garden beet, large quantities of sugar beets are grown in this country, from which a high grade of sugar is made. In Colorado, California, and other Western States are many large sugar-beet factories which manufacture large quantities of beet sugar. Sugar beets are also largely and successfully used as food for stock.

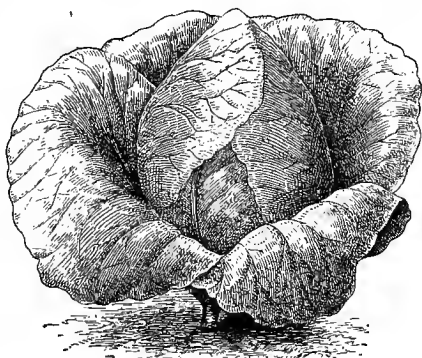


Kohl-rabi.

Mangel-wurzels. — These plants generally have flesh-colored roots covered with white, pink, red, orange, or purple skin. Instead of growing its main root entirely below the soil, as is the case with the sugar beet, it frequently has two thirds or more of the root above ground. It is valuable only for stock feeding.

Turnip Family. — This group is supposed to have arisen from a plant native to the coasts of western and southern Europe. It was introduced into England about 1650. The leading forms that have been the outgrowth of this plant are the cabbage tribe, including the common cabbage, cauliflower, broccoli, kohl-rabi, Brussels sprouts, and kale, and in another distinct tribe we find rape,

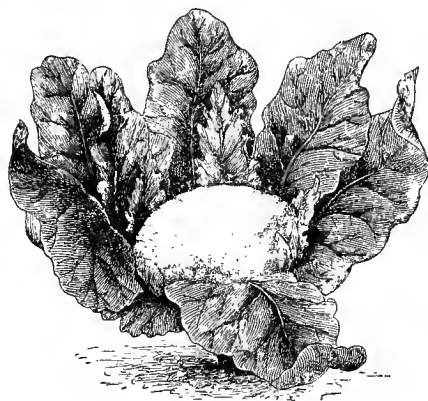
Swedish turnip, and the common turnip. Both forms of turnips consist of a thickened stem and root. The kohlrabi has a stem which forms a turniplike enlargement above the ground. In the cabbage we find round, thick, and fleshy, strongly veined leaves which form a rounded head on the summit of a short and stout stem. This plant is a biennial and consequently waits until the second year before forming its seed.



Cabbage.

Cauliflower and broccoli have nearly all the nourishing matter concentrated in short, imperfect flower branches collected into a flat head.

Kale is very much like the natural form of the parent species in that its fleshy leaves do not form a head. The plant



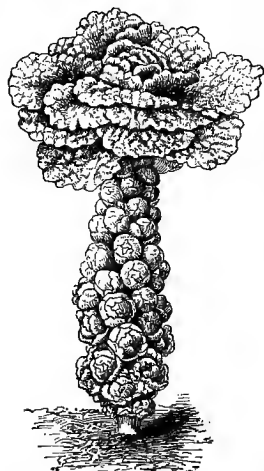
Cauliflower.

known as Brussels sprouts has numerous small heads along the stem below the top leaves. Common turnips and rutabagas or Swedish turnips are both valuable stock foods and grow well in cool, damp climates. They may be sown in beds or rows according to the taste of the planter. The seed should be sown at a depth of one fourth to one half an inch.

In growing cabbage the seed may be sown in beds and the young plants transplanted twenty to thirty inches apart.

Radish. — This plant is one of our common vegetables with which all are familiar. In sowing we should scatter from fifty to

one hundred seeds to the square foot and cover with a light layer of soil not more than one fourth of an inch deep. The soil should



Brussels sprouts.

be kept moist, but it must have plenty of ventilation. Many sow radish seed in rows instead of in beds. To keep a constant supply successional sowing from a week to ten days apart should be made. Fertilizers containing nitrate of soda when added to the soil improve the flavor of the radish. It is found best not to sow radishes where radishes, turnips, or cabbage were grown on the soil during the preceding year.

Horseradish is grown from pieces of the roots of the plant, since seed is rarely ever produced by it. The roots of the plant are grated and used for flavoring.

Rape. — Of all the forage crops there are none that will give so large a yield for so small an outlay. It is especially valuable for green manuring and pasture. It grows rapidly and readily adapts itself to different soils. Farmers prize it highly in feeding for both pigs and sheep. The best variety to plant in this country is probably the Dwarf Essex.

The ground should be prepared the same as for turnips, and the seed may be sown in June or July in rows a little over two feet apart. It may be either drilled or sown broadcast. The amount of seed sown varies from three to five pounds per acre.

Carrots. — The carrot is one of our most useful garden vegetables and for feeding stock it can hardly be surpassed. It is especially recommended for horses and milch cows. Any land if properly cultivated will yield satisfactory crops. It is best to sow the seed early in the



Radish.

spring, but good crops have been grown from seed sown as late as the middle of June. For field culture it is best to drill the seed in rows eighteen to twenty-four inches apart. The depth of the planting should not exceed one half inch, and when possible the soil should be firmed by rolling.

Salsify. — This plant is sometimes called the vegetable oyster because of its peculiar flavor. It has long, white, tapering roots which grow best in a light, rich soil. Sow the seed early and rather deep. The roots may be left in the ground all winter if protected from frost by covering them with a layer of straw.

Parsnips do well on deep, rich, sandy soil, but they will grow on nearly any loose, mellow soil. Their true value in stock feeding is just beginning to be appreciated. They are more valuable and nutritious than carrots or turnips but more difficult to harvest. Parsnips are especially recommended for dairy stock.

EXERCISES

1. Plant seed of several root crops and note the relative growths.
2. Try various kinds of soil and note results in growth with the same plant.
3. Ascertain whether sugar beets are adapted to alkaline soils.

QUESTIONS

1. Name some of the root crops.
2. Describe the cultivation of beets.
3. Discuss the value of mangel-wurzels.
4. Discuss the turnip family.
5. Describe the cultivation of radish.
6. For what kind of stock is rape especially recommended?
7. Discuss the cultivation of carrots.
8. Describe the salsify plant.
9. On what kind of soil should parsnips be planted?
10. For what kind of stock are parsnips recommended as a feed?

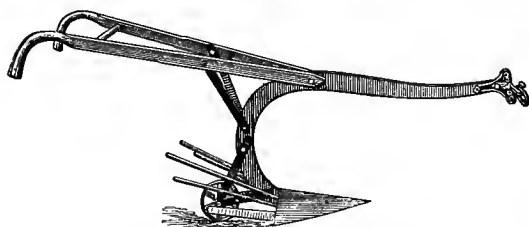
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XIX. TUBER CROPS

Rootstocks. — Creeping stems or branches growing beneath the surface of the soil, or partly covered by it are called rootstocks. Tubers may be regarded as portions of a rootstock greatly enlarged and provided with buds or eyes on the sides. The potato and the sweet potato form our two most important tuber crops.

The Potato does best in a rich, well-drained soil. The sandy loams in Colorado, Oklahoma, and Ohio seem especially favorable to its



Potato digger.

growth and development. In these States, under favorable circumstances, a yield of one hundred to one hundred and fifty bushels to the acre is not unusual. On the

market such potatoes usually bring from fifty cents to a dollar a bushel and make a profitable crop. The potatoes are usually planted in rows and generally about twelve bushels of seed are sown to the acre. For digging farmers frequently use the potato digger, which saves much time and labor.

There are numerous varieties of potatoes grown by farmers; the Early Rose and the Minnesota Triumph have been found to give excellent results in the Middle West.

The potato is a native of this continent. The Spaniards found the Indians eating this vegetable wherever they went in the valleys and along the slopes of the Andes. Later the potato was introduced into Virginia by the Spaniards, and from there it was carried to Ireland by Sir John Hawkins. The early use of the potato by the Irish caused it to be known as the Irish potato. At first it was used as a food only for cattle and hogs; but later, during the famine period, it became an article of general food, not only among the Irish,

but in many parts of Europe. To-day Europe leads the world in the production of this vegetable. Germany alone produces at least one fourth of the world's crop. We grow several hundred million bushels annually in the United States. Our most productive States are New York, Minnesota, Wisconsin, Michigan, Pennsylvania, Oklahoma, Colorado, Utah, and California.

Several important commercial articles are now manufactured from potatoes, among which may be mentioned alcohol, starch, glucose, and artificial ivory.

Jerusalem Artichoke. — This is really a species of sunflower which has been known and cultivated in both Europe and America



Gathering the potato crop.

for the past two hundred years. This species produces tubers which look very much like potatoes. Farmers may cultivate and handle this crop in the same way as for potatoes, but the tubers are usually plowed up and left on the ground as feed for hogs.

Chinese Yam. — These plants have a food value similar to sweet potatoes. They have large, thick roots which make them hard to dig. They are propagated by means of small tubers. The Chinese yam makes a valuable winter food for hogs.

Chufa. — This plant produces an abundance of small tubers and grows best on sandy soils. It is grown chiefly for hogs.

Sweet Potatoes. — Strictly speaking, the sweet potato should be classed as a root crop. The enlarged portions of its roots are styled tuberous roots. It easily adapts itself to thin, loamy soil and grows well in nearly all parts of the Southern States. The long-leaf pine soils of Georgia and Florida seem especially conducive to its growth and flavor. The plants are grown from slips usually obtained from nurserymen or from the hothouse. These slips are set out in rows three or four feet apart. Since the plants do not grow well in wet or heavy soil, it is best to place them in ridges. Sweet potatoes under favorable conditions yield from two hundred to three hundred bushels per acre, and since they usually sell from 75 cents to \$1.25 per bushel they make a profitable crop. Some farmers regard sweet potatoes as an excellent stock food, especially for hogs; but the scarcity of sweet potatoes and their high price practically bar their use for this purpose. The vines should always be cut and the potatoes dug before a severe frost or freeze comes.

QUESTIONS

1. What are (a) rootstocks, (b) tubers?
2. Discuss the cultivation of potatoes.
3. What States seem especially adapted to potato growing?
4. Calculate the value of ten acres of potatoes at one hundred bushels to the acre when potatoes are worth seventy-five cents per bushel.
5. What kinds of potatoes are grown in your locality?
6. What commercial articles are now manufactured from potatoes?
7. Describe the Jerusalem artichoke.
8. Discuss the value of the Chinese yam and the chufa.
9. Discuss the cultivation of sweet potatoes.

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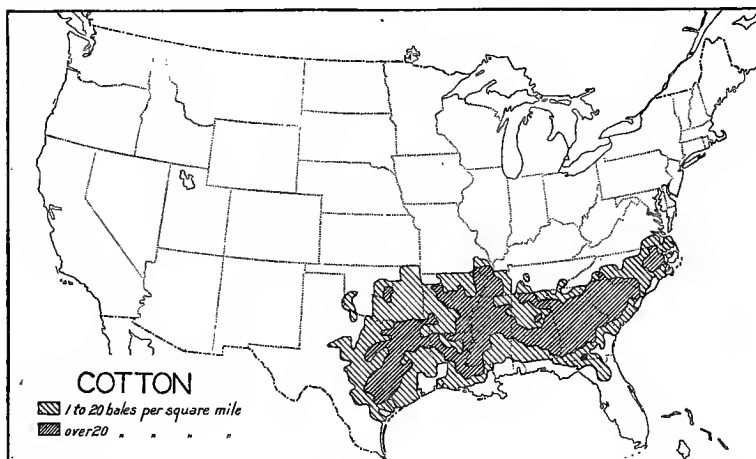
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XX. FIBER-PRODUCING PLANTS

PLANTS that are grown for their fibers are usually spoken of as fiber plants. There are two common sources of fibers, plants and animals. Perhaps the simplest test for distinguishing between the two kinds is by burning. The vegetable fibers burn to a white powdery ash, while the animal fibers leave a crisp coal. The most important plant fibers are cotton, flax, jute, hemp, ramie, sisal, maguey, and Tampico or istle. The most important animal fibers are wool and silk.

Cotton is supposed to have been first cultivated in southeastern India and from there it is said to have been brought to Europe by



Alexander the Great. It was found in cultivation in Mexico, the West Indies, Brazil, and Peru at the time the western continent was discovered. At first the great labor and cost necessary to remove the lint from the seed made it a somewhat unprofitable crop. The invention of the cotton gin by Eli Whitney in 1792 removed some of these difficulties. Later improvements in meth-

ods of handling have made cotton one of the most profitable crops that can be raised in the South. Although cotton was originally a tropical plant, it makes its best growth in temperate climates. In fact, some authorities think that by proper selection of hardy cold-resistant plants the time may come when the plant can be made to grow and thrive in many States now considered too far north for its successful culture. In the United States cotton seems to make its best growth in the Gulf States and the Atlantic States as far north as Virginia; it is being successfully grown in Kentucky, Missouri, Arkansas, Tennessee, and Oklahoma. Cotton usually makes its best growth in medium loams and well-drained soils.

The principal varieties of cotton are: Upland, India, Sea Island, Egyptian, and Peruvian cotton. The Upland and the Sea Island are American grown.



United States.

Rest of the world.

The world's cotton crop.

American Upland Cotton. —

This is the ordinary cotton that we find growing in the cotton belt of the United States. It has a stout stem about a quarter of an inch thick and grows one to five feet high. The

leaves are large and are three to six inches long and two to five inches wide. The leaves of this variety generally have five very distinct lobes.

The flowers open at sunrise or just before and close late in the day, never to open again. In the morning, on opening, they are creamy white, but during the day they gradually turn pink. By the following morning the deep pink portion of the flower falls away and the young capsule or boll may be seen. The bracts surrounding it are frequently called squares by farmers. The bolls grow until they reach the shape and size of a hen's egg. The lint is very fine in texture and is short, so that this variety is commonly known as short-staple cotton. There has been developed a long-staple variety which is now grown in considerable quantities.

India Cotton. — This plant is cultivated mostly in southern Asia. It has more slender, less woody stems, with leaves having

rounded edges, and has smaller and more spherical bolls than the American variety.

Sea Island Cotton. — Originally this variety of cotton was a native of the West Indies, but now it is grown on islands and lands near the coast of South Carolina, Georgia, and Florida. It is also grown to some extent on the sandy soils of the interior portions of these States. This plant grows three to eight feet high, has long flexible branches, three-lobed leaves, and creamy yellow flowers



Picking cotton.

instead of white flowers. The seeds are free from fuzz and are small, black, and smooth. It is a more costly crop to raise than the upland cotton, but commands a higher market price because of its greater length of lint and fine quality.

Egyptian Cotton. — This plant is grown on the irrigated lands of Egypt. It has been developed from Sea Island cotton by cultivation and environment. It seems especially well adapted for the manufacture of yarns and mercerized goods.

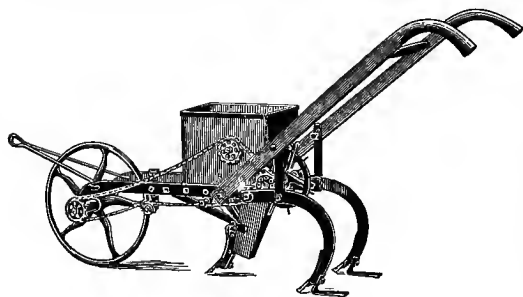
Peruvian Cotton. — As the name indicates, this plant is a native

of Peru, but it is also grown to some extent in Brazil. This variety is shorter and coarser than American cotton. The seeds are similar to Sea Island cotton, but cling together in a compact cluster.

Culture of Cotton. — The ground is usually prepared for cotton in February and March, and the seeds are usually planted in April in rows four feet apart. The seed is usually planted by a one-horse cotton drill or by a corn planter specially adjusted for cotton. The amount sown varies from one to three bushels per acre.

The sprouts soon come through the soil, and the plant begins to flower by the middle of June. Finally the blossoms drop

off and the little bolls of cotton take their place. Within two months the bolls mature and open. The plants continue to bloom, however, until September. The picking season extends from August until



Cotton planter.

November or a little later, and as the bolls mature at different times about four pickings are necessary in order to gather all the crop. The cost of picking a bale of five hundred pounds is about six dollars. The cost of ginning and baling is about one dollar, and usually the planter must spend another dollar or more for insurance and storage charges pending the sale of his cotton.

Gins. — The gins now in universal use are known as the saw gin, invented by Whitney, and the roller gin. The latter has been in use for ages. The roller gin gives the most satisfactory results for upland cotton, but the saw gin is generally considered preferable on account of its greater capacity. The seed is fed into a hopper against revolving saws which remove the lint and allow the seed to drop through openings provided for that purpose. A revolving cylinder studded with bristles removes the lint from the saws, and at the same time by its revolution a draft of air is created which carries off the lint as fast as it is removed from the saws

and delivers it to the press. The ordinary gin usually carries about seventy saws and has a capacity of a bale and a half an hour.

Bales. — There are two kinds of bales in use, known as the square bale and the round bale. This baling is accomplished by means of heavy pressure through machinery which squeezes or compresses the cotton together so that a great quantity is forced into a space about four feet square and five feet in length. It is then wrapped in coarse cloth and bound up with iron bands or hoops. The square



Baled cotton.

bale generally weighs from four hundred and fifty to five hundred pounds, while the round bale is usually limited to two hundred and fifty pounds. The former is extremely unwieldy.

Cotton Judging. — In judging cotton straighten out the lint and note the lengths, and bear in mind that the greater lengths make the larger tufts. Also observe whether the sample is free from dirt and trash and whether it has been damaged by careless ginning. The sense of touch may also be brought into requisition to good advantage. Unfortunately we have no well-defined standards for

grading cotton, and many of our expert cotton buyers seem to be unable to give good reasons for their judgment. The principal grades usually recognized are as follows: fair, middling fair, good middling, middling, low middling, good ordinary, and ordinary. All grades above the middling grade are designated as full grades. The price per pound may vary from five to fifteen cents or higher according to the season of the year and the grade of the cotton.

Cotton Products. — Some of the valuable products of cotton are the lint, the seed, oil, oil cake, cotton-seed meal, and hulls. A

ton of seed will yield forty pounds of lint, eight hundred pounds of hulls, eight hundred pounds of meal, and forty gallons of oil. From the lint is made cotton cloth and thread.

Flax. — Flax has been cultivated from the very earliest times, and it is said that the ancient Hebrews and Egyptians wore clothing made from its fiber. The variety generally used in this country is derived from a small annual plant that is found in some of the places bordering on the Mediterranean Sea. Belgium and Russia raise vast quantities of flax in the Old World, while the United States and Argentina lead all countries in its production on this continent.

The principal flax-producing

States in our own country are North Dakota, South Dakota, Minnesota, Michigan, Wisconsin, and Washington. Flax will usually grow where wheat will grow successfully, but it thrives best in cool, moist climates and on well-tilled sandy loams.



Flax plant.

Description of the Plant. — Flax is an annual which grows to a height of two to four feet, and it bears on the end of its branches clusters of pretty blue or white flowers. It has a threadlike taproot to which are attached a few tender lateral branches. The seeds are small and have a bright polished surface, and vary in color from yellow to a light or dark brown. The culture of flax when grown for seed is similar to that of spring wheat, and two to four pecks of seed are required to the acre. When grown for seed only, the crop may be harvested with a self binder, shocked, and thrashed with an ordinary thrashing machine; but when grown for fiber the crop must be pulled by hand. This is necessary for the following reasons: (1) to secure straw of full and even length; (2) to avoid stain and injury of the lower portion of the straw, which would occur if it were cut and shocked like wheat; (3) to insure better curing of the straw; (4) to avoid the blunt cut ends of the fiber which results when the stalk is cut.

Uses. — Large quantities of flax are raised for seed, which often sells for a dollar a bushel. From the seed is obtained an oil which is used extensively in the manufacture of paint, varnish, and printer's ink. It is also used in the manufacture of oilcloth, linoleum, artificial rubber, and soap. The plant furnishes two forms of commercial fiber that are of value. One is the straight, long lint which is used in the manufacture of fabrics; and the other is the short, tangled fiber called tow, used for seaming joints and calking boats, for upholstering, and for making bagging, paper, and twine. The finer and longer fiber is used in the manufacture of laces, fine linens, dress goods, crash and towel goods, and thread. Other valuable products are the hulls and linseed meal which remain after the oil has been extracted from the seed. From these a kind of oil cake is prepared which forms a valuable stock food.

Grading. — The usual legal weight of flaxseed in the United States is fifty-six pounds to the bushel. The standard for marketing purposes is No. 1 Northern grade, which must weigh fifty-one pounds or more per bushel and must not contain more than one eighth damaged seeds. Our annual production is over twenty-five million bushels.

Hemp. — This plant is a native of Asia and has been cultivated in China from very early times. It is a rough, sturdy annual, grow-

ing from ten to fifteen feet in height, which thrives best on most fertile soils in temperate climates. It can be grown successfully throughout the corn belt of the United States, but is grown chiefly in the blue grass regions of Kentucky and Tennessee.

Uses. — Hemp is grown in this country chiefly for its fiber which we use for cordage and warp for carpets, and also for making sailcloth. In some of the old countries hemp is largely grown for its rich oily seed.

Jute. — Jute resembles hemp and may be successfully grown on rich alluvial soils of the cotton belt, but it is principally grown in Bengal, India, and in China. It is used as coverings for cotton bales, and for making bagging, twine, and carpets.

Ramie. — This is a perennial shrub which somewhat resembles hemp in its appearance and growth. It grows well in the Gulf States, but the world's chief supply is grown in China, Japan, and the Malay Archipelago. It is used for making coarse fabrics and cordage.

Manila Fiber. — This plant resembles the banana plant; it grows in the Philippine Islands and is propagated from suckers or seeds



Maguey plant.

set in hills nine to twelve feet apart. It grows to a height of eight to twenty feet and requires no cultivation. The yield varies from two hundred and fifty to five hundred pounds of fiber to the acre. The fiber is used for making hawsers,

ship cables, hoisting ropes, and for the best grade of binder twine.

Sisal, or henequen, is a tropical fiber plant growing on barren rocky land unfit for other agricultural purposes in Yucatan, the West Indies, and Hawaii. Its heavy, coarse leaves furnish yellowish white fibers used principally for making binder twine, cordage, coarse floor matting, and door mats.

Maguey. — The maguey plant is closely related to the sisal plant and is very similar to it. It is a native of Mexico, but it is now grown in the Philippine Islands and in a few other tropical climates. Maguey is cheaper than sisal and can be used for the same purposes.

Tampico Fiber, or Istle. — This plant grows wild on the arid mesas or table-lands of New Mexico, Texas, and Old Mexico. It is used in the manufacture of brushes and cheap grades of twine.

EXERCISES

1. Ascertain from the market quotations in the paper the price of cotton and calculate the worth of a crop averaging one fourth of a bale to the acre, in a field of forty acres.

2. If you live in the cotton belt, talk with a cotton buyer and get his ideas in reference to buying and selling cotton.

3. If no cotton is grown in your locality, correspond with schools in some of the cotton-growing States and get them to make reports to you in return for reports on products grown in your State.

4. Which is the most valuable, a crop of forty acres of corn or forty acres of cotton? Why?

QUESTIONS

1. Name some of the leading plant fiber crops.
2. Give a brief history of cotton.
3. Name the principal varieties of cotton.
4. Discuss the American Upland cotton.
5. Describe (a) India cotton, (b) Sea Island cotton.
6. Discuss Egyptian cotton and Peruvian cotton.
7. Discuss the culture of cotton.
8. Name and describe the different kinds of cotton gins.
9. Discuss cotton judging.
10. Name some of the products of cotton.
11. Give a brief history of the flax plant.
12. Explain the method of grading flax.
13. Discuss the cultivation of hemp and jute.
14. Describe (a) ramie, (b) manila fiber, (c) sisal.
15. Discuss (a) the maguey plant, (b) Tampico fiber or istle.
16. How many kinds of fibers can you find about home?
17. Bring samples of cloth, rope, carpet, matting, etc., and try to find out what kind of fiber is used in each.

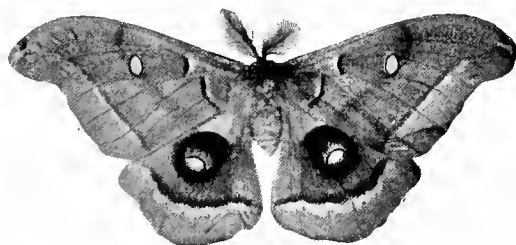
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XXI. ANIMAL FIBERS

THE principal animal fibers, silk and wool, are of such great importance that some mention must be made of them in connection with our study of sources of fibers. The value of the silk manufactured annually in this country is about \$125,000,000 and that of woollen manufactures is about \$400,000,000.

Silk. — Our supply of silk in the raw or unfinished state comes from France, Italy, Japan, and China. The raw silk is derived



American silkworm moth (*Polyphemus*).

from the cocoon of the silkworm which feeds on the leaves of the mulberry tree. Any one who has seen the American silkworm moth and its larva will have a fair idea of the Chinese silkworm, but

the latter is more delicate and requires very careful handling. The American silkworm may be found during part of the summer on the under side of the leaves of the oak or elm, but unlike the Chinese silkworm it has no commercial value.

The Chinese silkworms are produced from tiny eggs about the size of a mustard seed and are of a pale ash color. These eggs are laid by female silk moths, each moth laying, usually in June, three to five hundred eggs. During the hatching season, the following April, these eggs are kept in a room of a warm, even temperature. The eggs hatch into little black threadlike worms which require constant attention on the part of their owners. For the first few days mulberry leaves are cut up into small pieces and fed to the silkworms every half hour both day and night. This period is gradually extended to an hour, and finally when they have

reached their full growth they eat only three or four times a day. When the worm is thirty-two days old, it is about two inches long and a little larger than a common lead pencil. At this time it stops feeding entirely and begins to spin the silk fiber from its mouth, which it continues until its whole body is completely encased. This process requires from two to five days. Then the worms are placed over a slow fire of charcoal or wood and are killed by heating. Next



American silkworm.

the cocoons are placed in boiling water in order to soften the gummy substance which holds the threads together. Then the silk is unwound from the cocoons and reeled into skeins ready for shipping. When the silk reaches the manufacturer in this country, it is put through a process of twisting or spinning called

throwing. When this process is completed, the silk is ready for weaving and the loom. The United States consumes about one third of all the raw silk produced in the world. Nearly all of our large silk mills are in New Jersey, New York, and Pennsylvania, but smaller plants are found in nineteen different States.



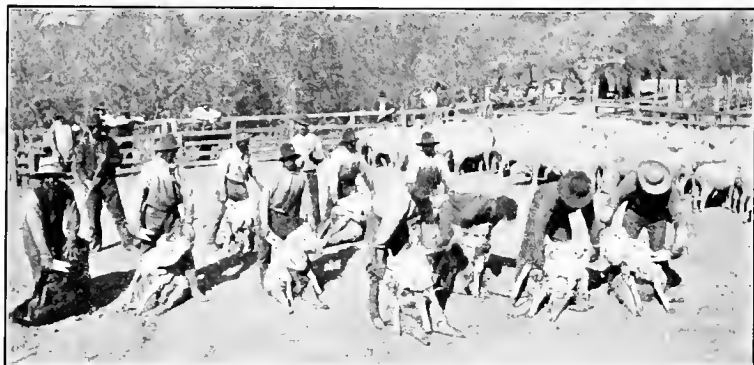
Chinese silkworms.

Products. — Our various silk and satin goods, ribbons, and thread are the most important products of silk fiber.

Woolen Fibers. — The best grade of wool fiber is furnished by the wool of merino sheep, a species brought to this country from Spain. It is estimated that three fourths of the sheep of the United States are of pure or mixed merino descent. In fineness of fleece and length of fiber it is excelled by no other breed in this country. About five hundred million pounds of wool is required annually for manufacturing purposes, and of this amount about

two fifths is imported from Australia, New Zealand, Argentina, and South Africa.

When the wool has reached a sufficient length and the season of the year is favorable, the sheep are caught and sheared. In some cases this is done by hand and at a cost of five cents per head, but in Australia and places where immense herds of sheep are maintained this work is done by machinery. After the shearing the



Shearing sheep, Wyoming.

wool is sorted and packed in bales for storage in the warehouse and subsequent shipment.

Grades of Wool. — Wools are classified on the basis of their length and strength, as: (1) clothing wools, comprising short, fine wool suitable for making high-grade woolen cloth; (2) combing wools, which are strong, over three inches long, used for worsted goods; and (3) delaine wools, which are fine, strong wools, two to three inches long, desirable for making delaine cloth.

Products. — The products of the woolen mills may be divided as follows: (1) wool goods for men's suitings and dress goods for ladies; (2) articles produced by worsted mills, including merinos, serges, hosiery, knit goods, etc.; (3) articles produced by carpet mills, such as rugs, carpets, etc.; (4) articles produced by felt mills, such as felted wool used for floor coverings, for making hats, and for other purposes.

Other Animal Fibers. — The hair of the Angora goat furnishes a fiber from which a fine grade of mohair goods is obtained. A

great deal of mohair is exported from Cape Colony in South Africa. From the Cashmere goat is obtained the fiber from which the famous Cashmere shawls are made. Alpaca, vicuna, and camel's hair cloth should also be added to this list. The llama of South America produces a wool fiber for which the animal is highly valued, although ordinarily it is used simply as a beast of burden.

QUESTIONS

1. Name the principal animal fibers.
2. What can you say of the value of silk and woolen manufactures in the United States?
3. From what places does our supply of raw silk come?
4. Discuss the care of the silkworms.
5. Name some of the important products made from silk.
6. Discuss woolen fibers. How are they graded?
7. Name some important woolen products.
8. About how much wool is required each year for manufacturing purposes?
9. Name the centers of the woolen industries.
10. Name some other important animal fibers.
11. If you have seen a sheep sheared, tell how the wool looked and how it was handled. When was the wool clipped? Why at this time of the year?

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XXII. ROTATION OF CROPS

FARMERS have learned by experience that it is not wise to attempt to grow the same crop year after year in the same field without change, and they have also learned that certain crops must follow each other in a certain order to secure the best results. Thus the farmer may plant corn the first year, potatoes the second year, wheat the third year, and clover the fourth year. This change of crops in regular order and according to fixed principles we call *rotation of crops*. During the fifth year, the farmer may, if he chooses, repeat the crop raised during the first year and obtain good results. In some of the States of the Middle West farmers follow their corn crop with wheat or oats and this with clover. The latter is frequently sowed with the wheat, and it makes its growth after the wheat is cut and harvested. The clover crop is usually permitted to grow two years or more before a change is made. Generally speaking, we may say that at least four crops should be included in our scheme of rotation in order to secure the best yield possible.

Evils of the One-crop System. — Many farmers in the corn belt region of the United States raise nothing but corn year after year, and the yield diminishes with each successive crop until finally there is scarcely enough realized to pay the cost of the production. Many farmers in the Gulf States make the same mistake in attempting to raise nothing but cotton. The feed for their teams and the food needed for themselves, which might be easily raised on the farm, is bought in the market. Under such a policy it is not surprising that such farmers are frequently compelled to place a mortgage on their growing crop, on their teams, and on all their farming implements in order to secure the provisions they need while the crop is being made. Should this particular crop be a failure, the farmer would not only lose all of his labor and time, but all of his working capital. The man who attempts to raise only

one kind of crop year after year in nine cases out of ten is doomed to disappointment and ruin. Farmers would fare much better if they would attempt to raise two or three kinds of crops every year, so that if one crop should be a failure the loss would be made more than good by the other successful crops. A few years ago it was supposed that nothing but wheat could be successfully grown in northwestern Oklahoma, but to-day it is not an uncommon sight to see wheat, cotton, and corn all growing side by side in this same section of country. These same farmers have also learned that it pays them to raise their vegetables and to raise their own hogs instead of buying these from time to time. This mingling of crops on the farm is called diversified farming, and too much cannot be said in its praise. The hope of the future lies in diversified farming.

Rules of Rotation. — No special rules can be laid down for the rotation of crops, but in general we should select such crops as will be the most profitable to the farmer and most beneficial to the soil.

So far as the farmer's profit is concerned, crops should follow each other in such a way that he will have a paying crop every year. If two or three kinds of crops are raised each year that mature at different seasons, the demands on the farmer's time and work will be distributed, and his income will be distributed through the year in such a way that he will have money on hand at all times to meet his expenses as fast as they are incurred.

A second point that we should consider in our selection of crops is the enrichment of the soil with nitrogen. If possible, grow crops that secure most of their nitrogen from the air. This, we have already learned, may be done by growing legumes such as alfalfa, cowpeas, and clover.

Again, crops should rotate in such a way that plants having shallow roots will be followed by plants with deep and heavy roots, so that the unused nourishment in the lower layers of soil may be absorbed by the roots and made available. Thus crops of wheat and oats may be followed by clover to good advantage.

Another point to be considered is what crop will make the best use of that portion of the preceding crop that is left on the ground.

Farmers have learned by experience that wheat may profitably follow a crop of tobacco.

Our crops should also rotate in such a way that an abundance of feed will be furnished for live stock at all times, so that the farmer will not be under the necessity of buying any kind of feed for his stock.

A change of crops is likewise found necessary in order to keep down the spread of weeds, plant diseases, and insect pests. Some insects thrive on certain plants and disappear when these plants are not grown.

Advantages of Rotation. — Summing up briefly, we may say that the advantages of rotation of crops are as follows:

1. It retards soil exhaustion and prolongs the period of profitable culture.

2. The fertility of the soil is improved by the continuous growth of crops properly grouped. When left lying idle, soils grow up to weeds or are damaged by washing.

3. A change of crops deprives insects of their special kind of food and results in their removal or death.

4. Weed pests which accompany certain crops may be eradicated by proper selection of crops. Thus the dodder plant appears as a pest in alfalfa and the so-called red rice frequently appears as an enemy of the common rice plant.

5. The growth of legumes in our scheme of rotation increases the soil's store of nitrogen.

6. Rotation gives a better distribution of labor and affords continuous work for the farmer and his teams.

7. A rotation which enables the farmer to market his crops at different periods affords a better distribution of his income and enables him to meet his obligations as fast as they mature.

Examples of Rotation. — A great many combinations of crops are possible, but nearly all of them run for three, four, or five years. Some of those in common use are as follows:

1. *Five-year Rotation*

1ST YEAR	2D YEAR	3D YEAR	4TH YEAR	5TH YEAR
Tobacco	Wheat	Wheat	Clover	Clover
Corn	Oats	Wheat	Clover	Clover

2. *Four-year Rotation*

1ST YEAR	2D YEAR	3D YEAR	4TH YEAR
Corn	Wheat	Clover	Clover
Corn	Oats	Wheat	Clover
Corn	Potatoes	Wheat	Clover or Alfalfa
Corn	Potatoes	Clover	Clover
Potatoes	Wheat	Clover	Clover
Cowpeas	Cowpeas	Cotton	Wheat
Rye	Soy Beans	Winter Wheat	Clover
Grass	Corn	Potatoes	Oats

QUESTIONS

1. What have farmers learned about growing the same crop year after year?
2. Discuss the evils of the one-crop system.
3. What can you say of rules for rotation of crops?
4. Discuss the advantages of rotation.
5. Give examples of (a) a five-year rotation, (b) a four-year rotation.
6. Give a list of the rotations practiced in your neighborhood.

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XXIII. FERTILIZERS

EACH crop secures the necessary elements for its growth from the air and the soil. Each year certain minerals are removed from the soil, and it is evident that in course of time the supply of necessary minerals will become exhausted if not replenished by some means. This takes place when we grow year after year some crop that draws and requires a large supply of a certain mineral element from the soil. To remedy the evil the farmer must either grow a new crop that draws on a different element of the soil, or he must strengthen the soil by applying to it some substance that will supply the missing element.

Fertilizers Defined. — Anything that we may apply to a soil to make it more fertile or productive is a fertilizer. Fertilizers may be divided into two classes: (1) natural fertilizers, and (2) commercial fertilizers.

Natural Fertilizers. — In this class we may include those which occur in nature and may be applied with or without special treatment to make them useful as fertilizers, and those which are by-products of manufacture or farm operations. They are lime, marl, gypsum, gas lime, salt, wood ashes, leather meal, felt waste, hair waste, swamp muck, peat, leaves, straw, and barnyard or stable manure."

Lime and Gas Lime. — Lime (calcium oxide) is a compound of calcium and oxygen. It is produced by burning common limestone. Lime is an essential food of the plant, and it exercises a beneficial effect on the soil by overcoming and neutralizing any acids present. In many parts of Alaska so much acid is present in the soils that crops cannot be grown with success until enough lime has been added to counteract the sourness. The judicious use of lime liberates unavailable plant food, eradicates diseases, and improves the texture of the soil. Gas lime contains a great deal of sulphur in the form of sulphides which are somewhat injurious to plant life and should be applied to the soil in sparing quantities long before the planting of the crop.

Salt facilitates the absorbing power of soils, reacts with lime, and serves as a solvent for phosphates.

Gypsum (calcium sulphate) is a compound of calcium, sulphur, and oxygen. When burned, it forms a white powder known as plaster of Paris. When reduced to powder by grinding, it is known as ground gypsum. It furnishes lime to the soil and increases its solvent power. In the Eastern States large quantities of gypsum are used in fertilizing clover fields. Large beds of gypsum are found in western Oklahoma, New York, and Nova Scotia.

Marl is a mixture of sand and clay with varying proportions of lime, phosphoric acid, and potash. A great deal of this kind of soil is found in New Jersey and Virginia. Marl is a valuable addition to soils on account of its mineral constituents and their mechanical effect upon the soil. Both ground marl and gypsum may be applied to the soil by a drilling machine specially adjusted for the purpose or by a manure spreader.

Wood Ashes. — In timbered countries unleached wood ashes form a cheap and valuable fertilizer. They contain much mineral matter necessary for plant food, especially lime and potash. Both of these elements exist in wood ashes in such a form as to be readily available to the plant, and at the same time the ashes exercise a beneficial mechanical effect on the soil by making it mealy and easy to cultivate.

Leather Meal is the waste product from leather factories where shoes and other leather goods are manufactured on a large scale. Its most valuable constituent is nitrogen, and it is a good fertilizer for pastures and meadows.

Felt Waste is one of the by-products in factories where felt goods are manufactured. Its most valuable constituent is nitrogen.

Hair Waste. — This product may be obtained in very large quantities in cities where the original materials are utilized for manufacturing purposes and the hair remains as a waste product. In the cities where the large packing houses are located hair waste may frequently be purchased as low as two or three dollars a ton. It contains nitrogen and is a valuable fertilizer for orchards and pastures.

Muck and Peat. — In low wet places there frequently accumu-

late large quantities of partially decayed vegetable matter which is called muck or peat according to its consistency. In Florida and the Gulf States large quantities of this material are found in the hummocks or low bottom lands near the lake and river regions. Vast beds of it are also found in Alaska, where it is so rich in vegetable matter that it is frequently cut up into blocks, dried, and burned as fuel.

Muck is rich in organic matter and contains about .3 per cent of nitrogen, besides showing traces of lime, potash, and phosphoric acid. Onions, celery, and potatoes make fine crops in muck lands that have been well drained.

Leaves and Straw are chiefly valuable for the organic matter that they supply to the soil. Farmers frequently make a great mistake when they set fire to their straw stacks and burn them up. The straw makes good forage for live stock in winter; and the following spring, if scattered over the soil, the straw makes a cheap and valuable fertilizer.

Barnyard Manure is somewhat different from stable manure and should not be confused with that product. It is the manure found in feed lots where live stock is fed, and consists of the droppings of the stock mixed with the loose portions of the soil and with waste portions of hay or straw given the stock for rough feed and for beddings.

Stable Manure accumulates in stables where animals are kept and fed. In many stables the manure is allowed to accumulate, and dry straw for bedding is added from day to day as may be needed. It is more valuable than barnyard manure because its valuable constituents are not leached out and washed away by rains. When removed from the stable it should be placed in covered pens where it will be protected from the weather. A ton of manure consists of 75 per cent of water and 25 per cent of solid material. In the latter will be found from 10 to 12 per cent of ash and from 12 to 15 per cent of organic matter. There will be usually found present ten pounds or less each of phosphoric acid and lime, eight to ten pounds of nitrogen, and from six to eight pounds of potash. In order to prevent the loss of ammonia and nitrogen it is frequently found advisable to sprinkle the manure with gypsum.

Manure, in addition to supplying the much-needed plant elements to the soil, improves the condition of the soil in many ways. It binds together particles of sandy soil, makes dry soils more mellow or porous, and conserves the soil moisture for the use of plants.

Composts are formed by building up alternate layers of manure and of weeds, marl, leaves, etc. The various layers of material are thoroughly moistened with water as they are built up. The heap is finally rounded off into a cone-shaped pyramid and is covered with a layer of dry soil to absorb and retain all gases that are formed. Whenever possible the compost heap should be opened up occasionally and sufficient water added to make the whole mass thoroughly moist. This will check the destructive fermentation and will facilitate the formation of nitrates.

Commercial Fertilizers. — When the soil is kept in constant cultivation and the crops are sold year after year, the essential elements of plant food become exhausted, and frequently not enough manure is produced on the farm to supply the deficiency; farmers are then compelled to resort to special or commercial fertilizers. These consist of compounds manufactured expressly for use on soils, and they contain plant food in a form more highly concentrated and more readily available than that found in stable or barnyard manure.

Classes of Commercial Fertilizers. — All special or commercial fertilizers fall naturally into three classes:

1. Nitrogenous fertilizers, or those furnishing nitrogen.
2. Potassic fertilizers, or those furnishing potash.
3. Phosphatic fertilizers, or those furnishing phosphorus.

Hints on Fertilizers. — A reckless and indiscriminate use of fertilizers is never profitable. The farmer must know what elements are needed for the successful growth of a crop and the amount that should be applied in each case. Good tillage, proper rotation of crops, and a judicious use of natural manures or fertilizers will ordinarily insure successful crops. But it is frequently advisable to supplement the natural manures with concentrated commercial fertilizers that have been found beneficial to that particular crop the farmer is trying to grow.

Nitrogenous Fertilizers. — Since nitrogen is the basis of the

albuminoids of plants, the casein of milk, and the fibrin of the blood, it is essential to both animal and vegetable life. It is found in fertilizers in three forms: (1) in the form of a nitrate; (2) in the form of ammonia; (3) in the form found in organic matter.

Nitrates. — The most common nitrates are nitrates of soda, potash, and lime. Nitrate of soda consists of one part by volume of sodium, one part of nitrogen, and three of oxygen. It is found in vast quantities in the rainless regions of South America and especially in some portions of Chile. Nitrate of soda is easily dissolved in water and when in solution becomes immediately available for the use of plants. It is especially valuable for early and quick-growing crops on light, sandy soils. On account of the extreme ease with which it dissolves it is not advisable to apply nitrate of soda as a fertilizer to the soil in the fall or too early in the spring.

Nitrogen in Ammonia. — Ammonia gas consists of one part of nitrogen to three parts of hydrogen. It develops more or less in stable manure and can be detected by its characteristic odor. Ammonia readily combines with acids to form salts, the principal ones being ammonium sulphate, ammonium nitrate, and ammonium chloride. Sulphate of ammonia contains hydrogen, nitrogen, sulphur, and oxygen. It is a by-product from the manufacture of illuminating gas, from the distillation of refuse animal matter, and from the manufacture of bone black. Ammonium sulphate is very rich in nitrogen, containing about 20.5 per cent of this element. When used on soils containing clay or clay loams, it is found very beneficial.

Organic Nitrogen. — This is composed of both animal and vegetable matter and is derived from a variety of sources. It is found in dried blood and dried meat obtained as waste products from packing houses; in tankage, which is the dried refuse from slaughter-houses and large packing plants, which contains skin, bone, hair, and meat particles; in dried fish, a waste product from fish-canning establishments; in leather meal and horn meal; in castor pomace, or the refuse from the castor bean after the oil has been extracted; and lastly, in cotton-seed meal. These fertilizers may be applied in large quantities and at any time.

Potash Fertilizers. — Prior to 1860 all potash fertilizers were obtained from wood ashes and stable manure. Since that time

large quantities of potash fertilizers have been shipped from Stassfurt, Germany, where large deposits of potash salts have been found and mined. Some of the principal forms of potash fertilizers are: (1) kainit, (2) sylvinite, (3) muriate of potash, (4) sulphate of potash.

Kainit is composed of sodium chloride, magnesium chloride, magnesium sulphate, and potassium sulphate. It contains about $12\frac{1}{2}$ per cent of potash.

Sylvinit is similar to kainit, but most of the potash it contains is in the form of a chloride, while in kainit most of the potash is in the form of potassium sulphate. Sylvinit contains about 16 per cent of potash. Both kainit and sylvinite improve the physical character of the soil and have a valuable solvent effect upon phosphates.

Muriate of potash is potassium chloride and contains about 50 per cent of potash. It dissolves readily in water and is easily distributed through the soil.

Sulphate of Potash is composed by volume of two parts of potassium, one of sulphur, and four of oxygen. It contains about 50 per cent of potash and is valuable as a fertilizer for sugar beets, tobacco, potatoes, and fruit.

Sandy soils are generally lacking in potash and consequently are greatly improved by the application of potassic fertilizers. Clayey soils, on the other hand, are generally better supplied with potash, and their need for fertilizers containing this element is not so pressing.

Phosphatic Fertilizers. — These fertilizers contain phosphoric acid in the form of phosphates of iron, lime, alumina, and other metals. These phosphates fall naturally into two groups: (1) bone phosphates, (2) mineral phosphates.

Bone phosphates are derived, as we might expect, from the bones of animals and contain phosphorus in the form of calcium phosphate. When bone is treated with hydrochloric acid, the calcium phosphate is dissolved out and the soft animal matter remains; when bone is burned, the organic matter is removed and the calcium phosphate remains. Some of the principal forms of bone fertilizers are raw bone, bone meal, bone dust, boiled or steamed bone, bone black or animal charcoal, and bone ash.

Mineral phosphates form what is known as phosphate rocks. In the provinces of Ontario and Quebec in Canada there is a species of phosphate rock called apatite which frequently contains as high as 40 per cent of phosphoric acid. Large beds of phosphate rock are also found in North Carolina, South Carolina, Florida, and Tennessee, and these deposits vary in thickness from one to twenty feet. This form is known as land rock or land phosphate. Sometimes small nodules of mineral phosphates are found in river beds and are called river rock or river phosphates. Carolina phosphates contain from 26 per cent to 28 per cent of phosphoric acid. They were first worked in 1868.

The presence of phosphates in Florida was first discovered in 1888 and since then they have been mined extensively. A good phosphate bed is often more valuable than a gold mine. The Florida phosphates occur in three well-defined forms: (1) soft phosphate, containing from 18 to 30 per cent of phosphoric acid; (2) pebble phosphate, containing frequently as high as 40 per cent of phosphoric acid; (3) boulder phosphate, often containing 40 per cent or more of phosphoric acid.

Iron Phosphate is produced in large quantities in England, France, and Germany and is a waste product obtained in the manufacture of steel from phosphatic ores. It is usually put on the market in the form of a fine powder and contains from 15 to 20 per cent of phosphoric acid. It is highly recommended as a fertilizer for clay and sandy soils.

Guano Phosphate is obtained from the guano deposits found in South America and the rocky islands fringing the Pacific coast, and it is very rich in phosphoric acid and nitrogen. It is also found in the West Indies, but the greater part of the world's supply comes from the Peruvian coast. Guano consists of the manure and the dead bodies of certain fish-eating fowls that hatch and bring up their young in the rocky islands of the Pacific near Peru.

Manufacture of Commercial Phosphates. — The phosphates as found in nature are practically insoluble and cannot be used as plant food or fertilizers until subjected to certain treatment. Generally sulphuric acid is added to the pulverized phosphate, which converts it into acid phosphate containing three kinds

of phosphorous compounds: (1) soluble phosphoric acid, soluble in water; (2) reverted phosphoric acid, soluble in weak acids; (3) insoluble phosphoric acid, not soluble in water but soluble in strong acids. In good fertilizers this should not exceed 1 per cent.

Use of Fertilizers. — It is somewhat difficult to give rules for the use of fertilizers except in a general way. There are many sides to this question, such as the condition of the soil, the kind of crop desired, the nature of the climate, the composition of the fertilizers that are available, and many other things along this line.

Nitrogenous fertilizers, easily dissolved, had better be applied to the soil after the plant has begun to grow. Such fertilizers stimulate leaf and stem growth and are very beneficial to crops on soils poor in decaying vegetable matter. Lettuce, beets, asparagus, celery, turnips, cucumbers, melons, sweet corn, beans, peas, radishes, carrots, wheat, rye, oats, barley, and meadow grass are all greatly benefited by the use of nitrogenous fertilizers. The farmer may find it advisable to use other fertilizing elements, but the combination should be such that nitrogen in general should be the dominant element.

Phosphatic fertilizers in general when in a soluble form should be applied only a short time before the plant requires the food because of the tendency to change to insoluble forms. But mineral phosphates and like products which decay slowly may be applied a long time before they are needed by the plant. Phosphate fertilizers are especially beneficial to corn, clovers, turnips, swedes, sorghum, sugar cane, and the like.

Potash Fertilizers. — These should be applied some time before they are required in order to secure their complete distribution. The fall season is generally considered the best time for applying a potash fertilizer on heavy soils. It is recommended for clovers, potatoes, sweet potatoes, peas, beans, vetches, and flax. Sandy soils are as a rule deficient in potash and are benefited by the application of such a fertilizer.

Field Tests. — In order to determine what fertilizers are best adapted to his needs the farmer should lay off ten testing plots about twenty-one feet and four inches wide and one hundred and two feet long, or any other convenient measurements which will make a plot containing about one twentieth of an acre. If plenty of space

PLAN FOR TESTING GROUNDS. — SIZE OF PLOTS, $\frac{1}{20}$ OF AN ACRE

Plot No. 1.	Check No Fertilizer	Check No Fertilizer
Plot No. 2.	8 lb. Nitrate of Soda	8 lb. Nitrate of Soda
Plot No. 3.	16 lb. Superphosphate	8 lb. Muriate of Potash
Plot No. 4.	8 lb. Muriate of Potash	16 lb. Acid Phosphate
Plot No. 5.	Check No Fertilizer	Check No Fertilizer
Plot No. 6.	20 lb. Nitrate of Soda 16 lb. Superphosphate	8 lb. Nitrate of Soda 8 lb. Potash
Plot No. 7.	20 lb. Nitrate of Soda 8 lb. Muriate of Potash	8 lb. Nitrate of Soda 16 lb. Acid Phosphate
Plot No. 8.	40 lb. Acid Phosphate 8 lb. Muriate of Potash	8 lb. Muriate of Potash 16 lb. Acid Phosphate
Plot No. 9.	8 lb. Nitrate of Soda 8 lb. Muriate of Potash 16 lb. Superphosphate	8 lb. Nitrate of Soda 8 lb. Muriate of Potash 16 lb. Acid Phosphate
Plot No. 10.	Check No Fertilizer	Check No Fertilizer

is available, plots containing one tenth of an acre may be found more convenient for making rapid calculations. Some experimenters prefer to lay off plots containing just one square rod and apply the fertilizer at the rate of one pound per square rod or multiple thereof. The fertilizers should be mixed with fine earth and drilled in the rows or else should be sown broadcast just before the planting time of the crop. Each plot should be separated from the adjoining one by not less than four feet to prevent mixing of the fertilizing agents. Note carefully the yields made on each plot, the quality, quantity, weight, and time of maturity being made the basis of the comparison. Lay off your ground and apply your fertilizers according to the diagram on the preceding page.

If the space available for experimental purposes is small, only four or five plots need be used; and if the fertilizers mentioned above cannot be obtained, useful experiments may be made by using lime, wood ashes, cotton-seed meal, barnyard manure, stable manure, rotten straw, and chicken manure. When no ground suitable for a school garden or testing fields can be obtained, the experiments may be conducted with soil placed in tomato cans. If this plan is used, test the same fertilizer with soil from a number of fields and note the results. Repeat each experiment and thoroughly test your conclusions before announcing your results.

EXERCISES

1. Test the soil you are experimenting with and ascertain whether it is acid. To do this take a little soil from three to four inches below the surface and moisten it with a little water. Dip a piece of blue litmus paper in water and then put the paper in the soil. If the paper turns red, the soil is acid. What common element should be added to correct this condition? Before beginning the experiment test the water used and see that it is neutral. Note the kind of vegetation found growing on the soil.

2. Secure another portion of soil and test it for alkalinity by substituting red litmus paper for blue litmus paper in the experiments suggested in exercise 1. If the litmus paper turns blue, the soil is alkaline. When this condition exists how may the matter be remedied? Take soil containing stable manure for this experiment.

3. Test a small portion of lime with both blue and red litmus papers and note the results.

4. Test common wood ashes with litmus paper and compare the results with those obtained in experimenting with lime.

QUESTIONS

1. Show the need of soil improvement.
2. Name and describe the general classes of fertilizers.
3. Name some of the natural fertilizers.
4. Discuss the value of (a) lime, (b) salt, (c) gypsum.
5. Discuss the value of (a) marl, (b) wood ashes, (c) salt.
6. What is leather meal? Felt waste? Hair waste?
7. Discuss the value of muck and peat.
8. Discuss the importance of (a) leaves and straw, (b) barnyard manure, (c) stable manure.
9. What is compost?
10. Discuss commercial fertilizers.
11. Discuss the nitrogenous fertilizers.
12. Describe briefly the potassic fertilizers.
13. Discuss (a) the bone phosphates, (b) the mineral phosphates.
14. What can you say of (a) iron phosphate, (b) guano phosphate?
15. Discuss the manufacture of commercial phosphates.
16. Discuss the use of fertilizers.
17. Enlarge upon the necessity of field tests.

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XXIV. ORGANS OF VEGETATION

THE principal parts of the plant are the root, stem, leaves, flowers, and seed; each has its own special work to do in the development and growth of the plant. The first three are usually designated as organs of nutrition and the last two as organs of reproduction.

The Root. — The root grows downward and gives the plant a firm support in the soil. If we examine this part of the plant closely, we find that a portion of its surface is thickly covered with very fine rootlets, through which moisture and food elements are drawn from the soil for the use of the plant. These elements must undergo certain changes, however, before they can be appropriated and used by the plant. From the roots there is an upward current which carries the nutritive element of the soil through the woody parts of the stems to the leaves, where it is changed under the influence of the air and sunlight upon the leaves and made available as plant food. Cambium is the name given by old physiologists to the nutritive juice upon which the plant lives, and the cambium layer is the ring or zone of tender wood forming tissue between the bark and the woody part of the plant. This movement of the sap from the roots upward to the leaves we usually designate as the *upward circulation*. If we break off the top of a milkweed plant, we find that in a short time the sap movement will cause the accumulation of a large amount of the milky white juice of the plant on its broken surface. When grapevines are pruned in the spring, the exudation of a watery fluid from the cut surfaces is very noticeable. This sap movement is not due altogether to capillarity, but depends largely upon what is termed root pressure. By this term is meant the force exerted in supplying the water from the soil. With many plants this force is strongest in the spring and gradually decreases as fall and winter approach. The amount of moisture present in the soil, temperature of the

soil, and the time of the day also influence this force. With the grapevine it gradually increases until noon and then begins to decrease, while in the case of the sunflower the maximum pressure is reached before 10 A.M.

From the leaves the sap current carries the newly formed plant food downward through the cambium layer to all parts of the plant where nourishment is needed. If we girdle the small twig of a tree and destroy the cambium layer, the downward circulation of the plant food will stop where the bark is cut and will cause a noticeable enlargement of the twig at that point.

The Stem. — We have already seen that the stem and its branches are the channels through which the sap movement is carried on between the roots and the leaves of the plant. In addition to this the stem also bears the leaves, buds, flowers, and fruit of the plant.

Stems may be classified as (1) erect, when they grow in an upright position; (2) prostrate, when the branches lie prostrate on the ground or nearly so as in the strawberry; (3) climbing, as in the case of the morning-glory and hop vine, where the stem twines about the support. Other examples slightly different are seen in the grapevine, woodbine, and the common gourd plant.

The Leaves. — If we place a fruit jar over a small plant, we find that in a very short time the inner side of the jar is found covered with small drops of water, which has been given off by the leaves. This process is called transpiration, and the amount of water given off through the leaves in this way is much larger than one would think. It is estimated that more than three hundred pounds of water pass through a plant in the process of transpiration for every pound of dry solid matter assimilated by the plant. An acre of good grass land will exhale ordinarily in well-watered regions not less than thirty hogsheads of water every day.

The leaves of the plant correspond in a measure to the lungs of animals. The carbon dioxide of the air is the element that feeds the plants, and without it they cannot grow. Although there is only about .03 per cent of this gas present in the air, Draper says that if it were taken away in an instant, the whole surface of the

earth would become a desolate waste without the possibility of vegetable life. The carbon in plants and animals all comes from the air.

In 1771 Priestley discovered in his experiments that leaves sometimes exhale carbon dioxide and sometimes oxygen, while at other times no gas at all seems to be given off. In 1779 Ingenhousz proved that oxygen is given off only when the leaves and the water in which they were immersed were exposed to the sunlight, and that carbon dioxide is given off in the dark. Carbon dioxide, it seems, enters the leaves of the plant by virtue of the forces of diffusion and osmose, and the green parts of the plant have power to decompose this carbon dioxide in such a way that the carbon is retained by the plant while the oxygen is permitted to return to the air. In the entire absence of light plants exhale no oxygen, but only carbon dioxide. In the dark this gas is not only produced within the plant by the action of oxygen upon some portion of it, but is actually given off from the plant into the air.

The amount of carbon dioxide decomposed at a given time depends on the intensity of the light and also on the kind of light. Experiments show that the decomposition of the carbon dioxide by the leaves is most rapid in yellow light and the least in violet. If the maximum decomposition by yellow light be taken as 100 per cent, the relative rate of decomposition of carbon dioxide by the various colors of light will be approximately as follows:

Violet 7.1	Yellow 100	Orange 63
Green 37.2	Blue 22.1	Red 25.4
Indigo 13.5		

Other gases may be absorbed also by leaves, such as the vapor of ammonia or of carbonate of ammonia added artificially to the air, but it does not seem that light in any marked way affects the amount absorbed. The growth of plants is greatly stimulated, however, by the presence of either one.

The air always contains small quantities of invisible vapor of water, and it is contended by some scientists that plants under certain conditions may absorb directly for their growth some of this vapor. This view is apparently borne out by the fact that

branches of willow or poplar trees that have been severed from the parent stem frequently live for months and occasionally form new leaves. In spite of the popular opinion, however, the foliage of ordinary plants does not usually absorb much of the water that falls upon it as rain, or that is deposited upon it as dew. In fact many leaves shed the water as fast as it falls on them. Hence in watering plants our care should be to apply the water in such a way that it will come in contact with the roots of the plant rather than with its leaves.

Another fact that we should not overlook is the power of the leaves of the plant to radiate heat. Experiments show that they radiate heat more readily than the soil. After a clear night we are likely to see grass fields loaded down with a heavy dew, while the adjoining bare land will be dry.

Leaves of the plant also play an important part by shading the ground and protecting it from the drying influence of the sun's

rays. In many cases the leaves protect the soil against the drying influence of the wind, which has less ready access to shaded land than to bare and exposed land.



Parts of a flower.

P., petal; *SEP.*, sepal; *S.*, stigma; *St.*, stamen.

The Flower. — The most attractive part of nearly every plant is the flower, which appeals so strongly to us through its beauty and fragrance. From the flower comes the fruit so highly prized as food

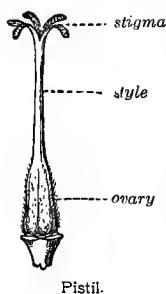
and the seed so necessary for the reproduction of plants. Every complete flower consists commonly of a circle of greenish leaves forming an outer envelope called the calyx, and an inner circle of bright-colored leaves forming an inner envelope called the corolla. This envelope is generally of some other color than green. Each leaf of the calyx is called a sepal, and each separate leaf of the corolla is called a petal.

Within the corolla we find a row of slender organs called stamens; and in the center of the flower, surrounded by the stamens, we

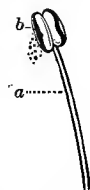
find the next set of organs called the pistils. The pistils and stamens taken together are called the essential organs, since their presence is necessary for the production of the seed of the plant.

A stamen consists of the filament or stalk, and the anther, which is the essential part. The anther contains a fine dust-like substance called pollen, which fertilizes the flower and makes it productive. The dustlike particles of pollen when examined under a microscope are found to be of various forms and shapes.

The pistil, when only one is present, occupies the center of the flower; when there are two pistils, they stand facing each other; but when there are several, they commonly form a ring or circle. The pistil when complete has three parts: the ovary, style, and stigma. The ovary is the rounded portion at the base, which is hollow and contains one or more ovules or rudimentary seeds. The style is a slender, tapering stem borne by the ovary. The stigma is found at the end of the style and it has a naked, moist surface upon which grains of pollen lodge and fertilize the ovules in order that they may become seeds.



Pistil.



Stamen.

a, Filament;
b, anther.

Some plants, such as the pear and the tomato, have blossoms which contain both stamens and pistils in the same flower, while others, like Indian corn, bear their stamens and pistils in separate flowers. Sometimes both staminate and pistillate flowers are on the same plant, but frequently they are on entirely separate plants. In the hemp plant and the hop vine the staminate

flowers grow on one plant and the pistillate flowers on another.

Flowers having both pistils and stamens are called perfect flowers, while those having only one of these organs are known as imperfect flowers.

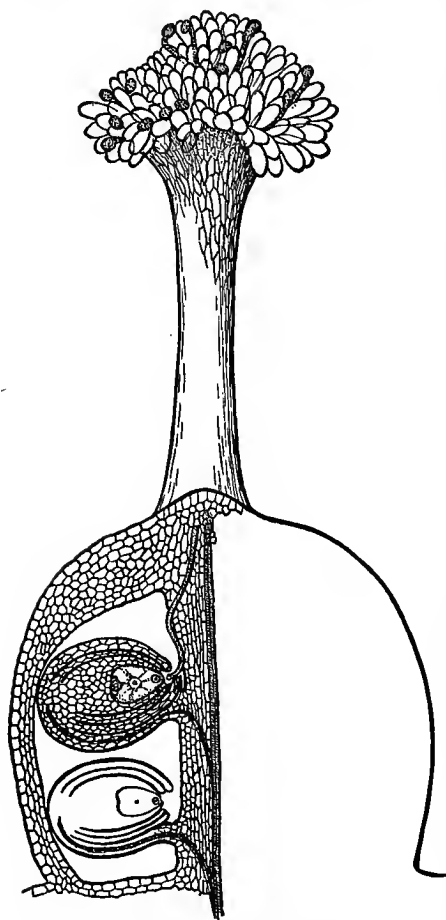
Pollination. — When the stigma has been supplied with pollen, a threadlike or tubelike growth is sent down through the pistil to the ovules and they become seeds. This process when completed constitutes what is known as fertilization.

Fertilization may be classified under three general heads: (1) *close fertilization*, which occurs when the pistil is fertilized by pollen from stamens growing in the same flower with the pistil

or from other flowers on the same plant; (2) *cross fertilization*, which occurs when ovules are fertilized by pollen from other plants of the same species; (3) *hybridization*, which occurs when the ovules are fertilized by the pollen of some other nearly related species.

Pollination may be accomplished through the action of the wind, which blows the pollen from the stamens of one flower upon the pistils of another flower as in the case of the pines and oaks; through the visits of insects, which carry pollen from one flower to another as in the case of willows and other dicecious plants; and lastly through hand pollination or other human agency. The last method enables us to know both parents of the seed we are growing and naturally gives the most satisfactory results.

To insure correct results it is usually found best to



Fertilization of the ovule.

The pollen tubes pass through the stigma and style, finally entering the cavity (locules) of the ovary.

remove all the anthers of the flowers upon which we wish to experiment sometime before their maturity, and after the flower

has been carefully pollinated it is necessary to cover the blossom with a thin bag to prevent the access of stray pollen. Finally, as a last precaution the fruit itself should be bagged to protect it against ravages of insects and birds. Each flower should be carefully tagged so that no mistake may be made in recording our results.

The seeds are the final product of the flower and as they approach maturity the outer portions of the flower perish and fall away. In general, we may say that every seed consists of an outer coat, an inner coat, and a kernel. The outer coat is often hard, while the inner coat is always thin and delicate.

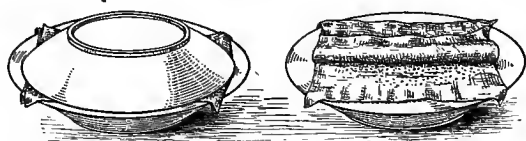
The kernel is the body of the seed within the seed coats and it contains the embryo. Sometimes the embryo constitutes the principal part of the kernel and sometimes a large part of it consists of albumin.

The embryo is the rudimentary plantlet, and its essential parts are the radicle and the cotyledons. The cotyledons are the original pair of leaves or seed leaves, and the initial stem on which they are supported is called the radicle. Interesting results may be had by germinating or sprouting some butter beans and noting the development of the embryo from time to time. Fairly good seed testers for germinating seed may be made by inverting saucers in soup plates or inverting small pie pans within other pie pans just a little larger. If the first plan is used, cover the saucers with moist blotting paper or cheesecloth and keep the seed damp until the sprouting is complete. Count the seeds and note the percentage that germinate, also note the time required for germination in different seeds. In high schools and colleges where the pupil is supplied with good equipment experiments should be conducted under different temperatures with a view to ascertaining at what temperature seed will germinate the most rapidly. Small sponges placed in a dish or glass of water may also be used as germinators when other materials are not available. In fitting up a seed tester by the first plan it is best to place a moistened cloth above the seed as well as below the



Bean seedling.

seed. Besides moisture the young plant must have plenty of air. If we plant wheat in one vessel and cover it with an inch or more



Seed tester.

of water, and place on the right of it another dish containing just enough water barely to cover the wheat, we find in two or

three days that the seed in the right-hand vessel which have access to the air will germinate, while those in the left-hand dish will not.

This experiment shows that ordinary plants must have air and that their seed must also have air before they will germinate. For the same reason, seed germinate slowly, if at all, in closely packed clayey soil, while, on the other hand, they germinate rapidly in loose soil because the air has access to them. We find that temperature also plays an important part in the process of germination if we plant a few grains of corn, a few beans, and a few clover seed in the same kind of soil in four different tumblers and treat them as follows: Set one tumbler in a refrigerator, one in a cellar, one in a warm room, and place the fourth one near a furnace or a stove. Record the number of seed used in each case and calculate the percentage of germination for each kind of seed and at each temperature. Ascertain the approximate temperature in each case by means of a thermometer. Repeat the experiment with reference to light by placing one tumbler where it will have sunlight, another in the light of the window but where sunlight cannot reach it, a third one in a darkened room, and the fourth one in a dark cellar; and note the results. From this experiment we see that light is likewise an important factor in germination.

EXERCISES

1. Secure a weed or some other plant and make a drawing of it, showing the roots, stem, branches, and leaves.
2. Estimate the amount of root surface and compare this with the amount of leaf surface of the plant secured.
3. Secure a flower, make a drawing showing its various parts, and give their names.

4. Make a seed tester. Test the rapidity of germination of several kinds of seed. Determine the amount of moisture needed.

QUESTIONS

1. Name the principal parts of the plant.
2. Describe the root and its growth.
3. Describe the stem.
4. Name the classes of stems.
5. Discuss the leaves and their functions.
6. Calculate the amount of water probably exhaled daily by the grass in a pasture of fifty acres.
7. Discuss the discoveries of Priestley and Ingenhousz.
8. Discuss the effect of colored lights on the decomposition of carbon dioxide by the leaves.
9. Discuss the power of leaves to radiate heat.
10. Describe the flower and its parts.
11. Discuss pollination.
12. What is (a) close fertilization, (b) cross fertilization, (c) hybridization?
13. Describe (a) the seed, (b) the kernel, (c) the embryo.

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XXV, PROPAGATION OF PLANTS

OF all the duties that devolve upon the farmer there is none of more importance than that of propagating plants, but this subject has never been given the serious attention by some farmers that it deserves. Mr. Luther Burbank, in the development of edible and thornless cactus and the world-renowned Burbank potato, has shown that we have much yet to hope for, in the way of discoveries concerning the propagation and reproduction of plants.

Plants may be propagated in five different ways: (1) by seedling; (2) cutting; (3) budding; (4) grafting; (5) layering.

The object of propagation is: (1) to renew the generation or prevent the stock from becoming extinct; (2) to increase the number of plants; (3) to develop new varieties under certain conditions; (4) to fix and perpetuate a special variety; (5) to strengthen and improve the fixed variety of any species.

Propagation by Seed. — This is the common method of propagating plants, and its success will depend largely upon the judgment we exercise in the selection of seed. The quality of the seed will depend upon their purity and vitality.

Purity. — One of the first requisites of good seed is absolute purity. It not infrequently happens that the seed we buy is mixed with the seed of weeds and other injurious plants, and much damage results in this way. In selecting our seed it is always best to buy from some reliable seed house, even if the price is much higher than that made by other houses of doubtful reputation. It takes time and considerable trouble to examine seed for purity, but it is sure to result in a great saving in the end. The vitality and purity of seed may be learned as follows: (1) by sowing a given number of the seed in a small space and noting the percentage which sprout; (2) close examination of the seed with the eye; (3) by examining the seed with a magnifying glass or microscope; (4) by the sense of touch in expert samplers and testers.

Vitality. — Sometimes our seed may be absolutely pure and

still the results obtained in sowing may be somewhat unsatisfactory. Correct size, form, color, and odor are not always sufficient to insure the germination of the seed that we sow. When the results under such conditions still prove disappointing, the seeds are lacking in vitality. The things that affect the vitality of seeds are as follows: (1) the maturity of the seed; (2) the vigor and general condition of the parent plant; (3) the age of the seeds; (4) the method of their preservation or the proper conditions of storage.

Maturity. — The significance of after ripening for the formation of perfect seeds cannot be overestimated, and there can be no doubt that *dead ripe* seeds are the best for sowing. This is clearly shown in the experiments made by Hellriegel. He selected a number of rye plants, from a good field of this grain, at five different periods of maturity. The first sample of seed was taken when both plant and grain were still completely green and the seeds were small and watery. The second sample was secured when the plant was still green, but the seeds were large and yielded a milky juice on being compressed. The third sample was taken when the straw was turning yellow and the seeds were full of starch, though still green and very soft. The fourth sample was obtained when the straw was yellow and rather dry and the seeds were hard and no longer juicy, but yellow ripe. The fifth sample was taken when both straw and grain were dry and the latter easily shaken out of the ears. About one hundred seeds of each sample were sown in good soil in earthenware jars. The percentage of germination is shown in the following tabular statement:

1ST SAMPLE	2D SAMPLE	3D SAMPLE	4TH SAMPLE	5TH SAMPLE
4 $\frac{1}{2}$ %	5%	9 $\frac{1}{2}$ %	36%	84%

Hellriegel says that the young plants from the overripe seeds were decidedly the strongest and most vigorous, the others being smaller and feebler very much in proportion as the seeds from which they grew had been gathered earlier.

Condition of the Parent Plant. — Sickly looking plants develop poor seed, and such seed produce feeble plants. It may be somewhat troublesome to go over a field of grain and select seed by

hand, but it will always pay in the end. Pick out such plants as you wish to reproduce and select your seed from them. In selecting seed corn we may consider the size of the ears of corn, the size of the individual grains, the number of ears of corn on each stalk, the percentage of blades and stalk in the plant, and other points of this kind.

We must also consider the yield, and the ability of the plant to resist drouth, inclemency of the weather, and insect pests. Mr. Abraham Fultz, about 1862, while passing through a field of bearded wheat in Pennsylvania found three heads that were beardless. He planted the seeds from these and found that the resulting crop was not only beardless but very productive. By saving all the seed and planting them again from time to time he soon had an ample supply of this new variety of wheat, which has long been famous under the name of Fultz wheat.

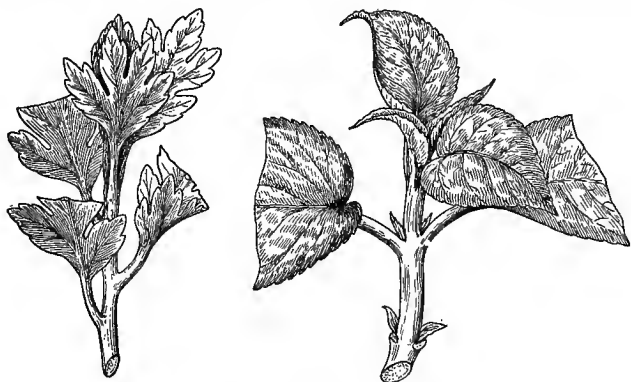
Variation in climate produces marked effects in the structure and habits of plants which sometimes may be turned to good advantage. Northern-grown potatoes on account of the shortness of the growing season mature early and do not lose this tendency when planted in Southern latitudes. For this reason we find it advisable frequently to secure our seed potatoes from Minnesota, Ohio, and other Northern States. When this is done we generally have more thrifty plants and better yields.

Age of Seed. — As a rule seeds do not germinate well when they are more than a year old, but some seeds retain their vitality for three or four years or even longer. Onions and parsnips do not retain their normal vitality for more than a year, and the seed after that time germinate very poorly. Maize and some of the larger grains retain their vitality for a much longer time. Varieties of maize have been found in the old tombs or Indian mounds of the United States, Mexico, and Peru, which some experimenters have succeeded in germinating, in spite of the great age of the seed, but such instances are rare. When time and conditions are favorable teachers should secure a quantity of seed, and plant samples of the same every year for a period of years and note the decreasing vitality of the seed from time to time. The results obtained with different seeds will be very interesting and instructive. In making your experiments see (1) that in each case the embryo or the

germ of the new plant is uninjured, (2) that sufficient warmth and moisture is present; (3) that the soil is loose and porous and free from injurious elements; (4) that the soil used is supplied with the proper nutritive elements; (5) that proper conditions of air and sunlight are provided.

Preservation and Storage. — Much depends on the care of the seed we select for use. Select as far as possible well-formed and perfect seed, and when necessary free them from all pulpy material that would cause them to decay. See that they are carefully dried in the sun or under a moderate temperature if artificial heat is used to hasten the process, and then store them in a cool dry place free from the ravages of rats, mice, and insects.

Propagation by Cuttings. — Another way of propagating plants is by cuttings. A cutting is a portion of the plant which when

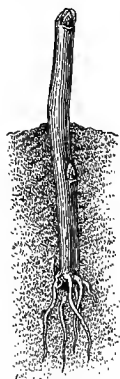


Green wood cuttings.

cut off and placed in the soil under proper conditions will take root and grow. This cutting should have at least one healthy bud.

Cuttings of some plants, like the willow, and the oleander, put out roots in a short time and grow very readily. Secure a small cutting of an oleander by cutting off the end of a healthy branch, remove all the leaves but two or three near the top of the twig, and place the cut end in a bottle of water. Keep the bottle near the window where the plant can have proper light and air, and in a few days tiny roots will begin to form. When sufficient roots have been formed, break the bottle, remove the twig, and transplant it

to a pot of warm moist soil, taking care not to break or injure the roots. Fruit jars with pasteboard covers through which the twig may be put will be better than bottles when it is possible to secure them. Cuttings may be made from green wood or hard wood



Rooted cutting.

according to the nature of the plant. When made in the fall or winter while the plant is dormant, they are called dormant cuttings. There are three general kinds of cuttings: (1) leaf cuttings, (2) stem cuttings, (3) root cuttings.

Leaf Cuttings.—There are some plants, like the begonia, which can be grown from leaves. The leaf is secured from a healthy plant and its base and stem are buried in moist sand. In a short time roots will develop at the cut ends and new plants will be formed.

Stem Cuttings.—These may be made of soft green wood or of mature hard wood. Of the soft kind we may take slips of ageratum, coleus, fuchsia, geranium, heliotrope, nasturtium, tomato, carnation, and the like. Of the hard wood we may take clippings of grapevines, currant plants, roses, dogwood, etc. In preparing soft cuttings we should secure shoots having not less than two nodes or joints, and the stem should be cut just below or near the lower node; Next reduce the leaf surface until only one half or one third of the leaves remain, and then place the cutting in a greenhouse bed of moist, clean, and rather coarse sand or in a saucer of clean sand in a sunny window. Cuttings of oleanders and the umbrella plant may be started in water without the sand. In case the umbrella plant is used, the leaves, instead of the stem, are immersed in the water. It is generally best to clip the tuft of leaves on the umbrella cutting to within an inch of the stem before putting it in the water for propagation.

Hard wood or dormant cuttings are taken from the mature wood of the last season's growth in the fall or winter, and they usually contain two or more buds. These may be taken any time after the leaves fall off before cold weather begins. See that the shoot is cut off just below the lower node, but allow one fourth of an inch of the stem to extend above the upper node. Pack the cuttings in green sawdust or moist sand and place them in a damp cool

place where they will not freeze during the winter.* A common cave or cellar may be utilized for this purpose.

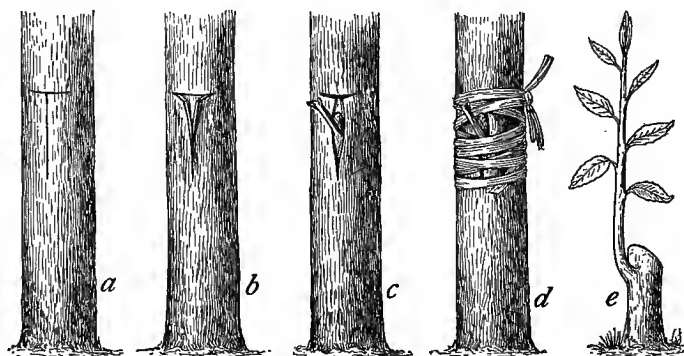
In the spring or when the weather is favorable plant the cuttings in an oblique position and cover them with soil up to the top bud. They should be cultivated frequently and kept free from weeds.

Root Cuttings. — Many plants may be propagated by root cuttings. In the horseradish and rhubarb plants these cuttings are really parts of underground stems bearing buds, while in the blackberry and quince they are cuttings from real roots which bear no buds or leaves. The ability of some plants, like mint, couch grass, etc., to spread so rapidly is due to the facility with which their underground stems take root and grow. Chopping or cutting up such roots only accelerates their propagation instead of checking it. In propagating blackberry plants it is best to make the cuttings 2 or 3 inches long.

Propagating Plants by Budding. — Budding consists in transferring a bud from one plant and inserting it in the bark of some allied or closely related plant in which it will become attached and develop. Many plants do not produce offspring like the parent stock when grown from seed, but buds always produce fruit like that borne by the tree or plant from which they were taken. Two methods of budding are in general use: (1) the pocket or T-cleft method, (2) the ring method.

The T-Cleft Method. — In this method a horizontal incision is made in the stock to be budded, and just below the center of this cut another incision is made in the bark at right angles to it so as to form a T-shaped cleft. These incisions should be made close to the ground and on the north side of the stock, which should be a hardy one-year-old seedling. Next secure the bud that is to be transferred, taking care not to injure the vascular bundles on its under surface, and insert it in the incision in the stock previously prepared, and adjust it so that the cambium layer of the bud will come in contact with the cambium layer of the stock. Then press the bark down close and wrap the wound carefully with moist soft twine, cotton yarn, raffia, or other suitable material. In about ten days the bud will unite with the stock if it takes, and the wrapping material should be cut away. At the same time the seedling stock should be cut off at the top to within an inch or two of

the bud, so that all the energy of the plant will be directed into the bud. This kind of budding should be done in the fall or spring



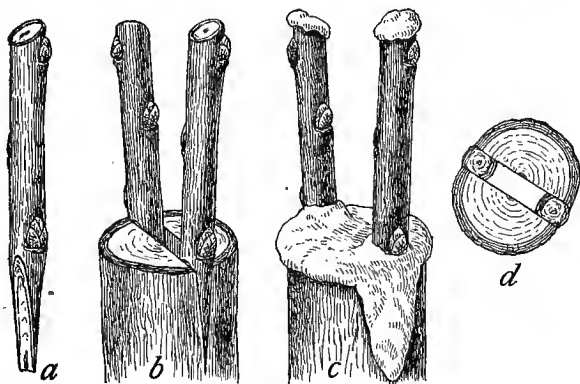
T-cleft budding.

when the bark will peel easily and mature buds can be easily procured.

The Ring or Annular Method. — In this method a ring or loop of bark extending nearly around the stock is removed, and a corresponding section containing the bud is removed from the other plant and inserted in this incision in the same manner practically as is done in the case of the T-cleft method. This is the usual method of budding pecans and oranges and is largely used in the South. By budding fine varieties of oranges on hardy seedlings able to withstand cold inclement weather we may be able to grow oranges in many States where formerly it would have been utterly impossible.

Propagating Plants by Grafting, or Grafts. — A graft is a small shoot of one tree inserted in another tree. It is so named from the resemblance of the shoot to a pointed pencil. The word *graft* itself is derived from the Greek word *graphein*, which means to write. The young twig or branch which is inserted we call the scion, and the young seedling tree in which it is placed we call the stock. The scions should be cut late in the fall from firm hard wood and should be packed in dry leaves or excelsior and kept in the cellar until needed for use in the spring. With reference to the method of insertion of the scion into the stock, grafting may be divided into (1) cleft grafting, and (2) tongue or whip grafting.

Cleft Grafting. — In this method of grafting we saw off or cut off the main limbs of the stock at points where they are sufficiently large to admit of being cleft. Then we cut out a wedge-shaped

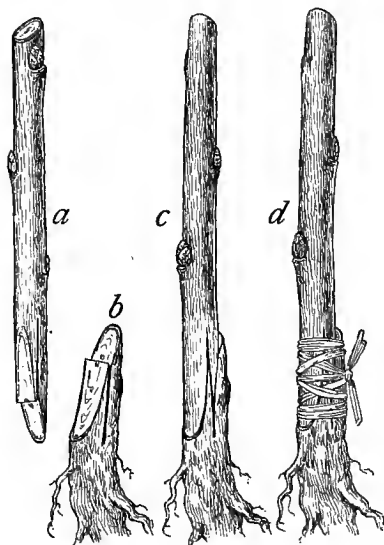


Cleft grafting.

piece of wood from the center of each branch sufficiently large to receive the scion.

Next, we prepare two scions by trimming them to wedge-shaped points so that they will fit into the cleft of the stock, taking care that each scion when placed in position will have at least two buds pointing obliquely upward. See that the cambium layer of the scion coincides with that of the stock, as in *d* of the diagram, so that the sap from the stock may flow into the scion and furnish it with proper nourishment. Then apply sufficient pressure to insure that union takes place, and carefully protect all exposed surfaces from the action of moisture and sunlight by covering them with a sufficient supply of grafting wax. If these details are carefully worked out we may reasonably expect success to attend our efforts. Grafting wax may be made by melting together one ounce of tallow or linseed oil, four ounces of rosin, and two ounces of beeswax. If the proportion of beeswax and rosin is increased, the grafting wax will be made correspondingly harder. After melting, the mixture should be poured into cold water, and as soon as it can be handled it should be taken from the water and pulled like taffy until it becomes light-colored and pliable.

Whip Grafting. — Secure a scion of the same size as the stock. Trim the scion at the lower end into the shape of a double wedge



Whip grafting.

as shown under (a) in the diagram. Then slip the scion into a double wedge-shaped cleft (b) as shown under (c), and finally wrap it as shown under (d).

The grafting cloth may be made by coating thin muslin with ordinary grafting wax.

Grafting by the two methods just described is known as *Stem Grafting*.

Root Grafting. — In this method the roots of seedlings one or two years old are used as stocks, and either the whole primary root or only a piece of the root may be used. The method of procedure is similar to that prescribed for ordinary whip grafting already described.

Propagating Plants by Layering. — This is one of the safest and simplest ways of propagating plants. The branches while still attached to the parent plant are covered with soil with the exception of the tips of the branches. In a short time roots are developed from the covered portions of the stem and a new plant results.



Layering.

The black raspberry and the strawberry are examples of plants that propagate by layering in nature. The currant and the grape are examples of plants that may be made to propagate by artificial layering.

EXERCISES

1. Let each pupil plant 100 grains of wheat and determine the percentage of vitality.
2. Propagate two plants by cuttings and write the results of the experiment.
3. Let each pupil prepare two specimens of work in budding.
4. Let each pupil prepare specimens of work showing the various kinds of grafting.

QUESTIONS

1. Discuss the importance of the propagation of plants.
2. Name the various ways in which propagation may be effected.
3. Name the objects of propagation.
4. Discuss the propagation of plants by seed.
5. Discuss the importance of purity and vitality.
6. What can you say of the necessity of maturity in the seed?
7. Discuss the condition of the parent plant and the effect of this on the seed.
8. What effect has age on germination?
9. Discuss the need of preservation and proper storage for seed.
10. Discuss propagation by cuttings.
11. Describe (a) leaf cuttings, (b) stem cuttings. Prepare specimens.
12. Discuss root cuttings.
13. Explain the art of budding.
14. Discuss grafting. Prepare specimens.
15. Describe root grafting.
16. Discuss layering. Illustrate.

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XXVI. IMPROVEMENT OF PLANTS

Origin of Domestic Plants. — Many of our common cultivated plants have been so changed and improved under the care of man that we can scarcely realize that they originated from wild inferior plants. The potato is not a native of Ireland, as many people suppose, but its home is in some of the high valleys of the Andes Mountains; and travelers passing through South America may often see Indians selling these wild potatoes in the streets of Peruvian and Bolivian cities. Many of these wild varieties are no larger than a common marble and have such a strong, disagreeable flavor that most of us would not care to eat them at all. The chrysanthemum was once regarded as a pestiferous weed, and the tomato at one time was grown simply as an ornamental plant and its fruit was regarded as poisonous. From the insignificant European crab apple many of the fine varieties of apple trees have been derived. Strawberries and blackberries afford striking illustrations of what changes may be brought about by careful cultivation, since the wild varieties of both plants are quite common in many parts of our country, and may be easily compared with the cultivated varieties. As we note the differences in the wild varieties and the cultivated varieties of the same plant, the question naturally arises by what means has the improvement of the plant been brought about. In reply we can say that all plant improvement depends on three factors: (1) variation, (2) heredity, (3) selection.

Variation. — This is the first requisite toward the improvement of plants and is the chief means through which progress is possible. By variation we mean the tendency of the plant to be unlike its parent. If we go out into a field of corn, we shall not find any two plants that are alike in all respects. One plant will have a tall stalk, another a thick, heavy stalk; one will have a large number of small, short ears, while another will have a few long, large ears. One ear will have heavy thick grains of a light color, while

another ear on a neighboring stalk may have small grains of a darker color. In the whole field we shall not find any two plants exactly alike. These slight differences give us the starting point for the improvement of the parent plant and for the origination of new varieties. When variation does not occur naturally to any marked extent, it may be brought about by (a) change in the food supply, (b) the action of light, (c) pruning, (d) cross fertilization, (e) bud variation.

The Food Supply. — Many experiments show that the food supply of plants is an important factor in bringing about variation. Japanese and Chinese gardeners for ages past have dwarfed many well-known plants by giving them a scanty food supply. In this way many varieties of forest trees have been dwarfed and so reduced in size that they might be grown in ordinary flower pots without difficulty. This is accomplished by starting the plants in sand which contains only a limited amount of the food elements needed by the plants. This method of starting and growing plants is called sand culture. In some cases water is used in place of sand, but in this case some kind of artificial support must be provided for keeping the plant in position. Hyacinths and many bulbs of like nature, as well as cuttings of rose bushes and of the so-called wandering Jew, may be made to grow in water containing the necessary food elements in solution. This is called water culture.

Experiments also show that excess of food elements causes much variation in the growth and development of plants. The greatest variation is due to the nature and kind of food elements supplied. One of the most important elements is nitrogen, which is very necessary to the successful development of all plants of heavy foliage and luxuriant growth. If we desire plants of small size with less foliage and more fruit, we find it necessary to use fertilizers containing potash and phosphorus. From this it appears that we may alter the character of the crop, and the quantity of the crop, by changing certain conditions of food supply.

The Supply of Light. — Another very important factor in producing variation in plants is the kind and quantity of light supplied. Interesting experiments to show the effect of colored lights on the growth of plants may be made in hothouses lighted

only by electricity. The change in light desired may be effected by using globes or bulbs of different colors.

Another interesting study is the effect of different kinds of light on plant growth. Experiments show that plants will grow under the influence of electric light and make satisfactory development. Acetylene gas has also been tried with some success. Natural gas and ordinary illuminating gas give off many products that are very injurious to plants, and they cannot be satisfactorily used in our experiments with plants unless arranged and placed in such a position that none of the injurious products of the gas can come in contact with the plants. Many scientists have supplemented the action of the sunlight by subjecting plants to the action of electric light at night, and in practically every instance the plants made greater and more rapid growth. This discovery is likely to be of little value until some cheaper and better method of getting electricity is found.

The amount and intensity of light produce a very marked effect on the growth of plants. Those grown under the action of sunlight in the open air generally make the most satisfactory progress. Interesting experiments showing this may be made by growing plants in a cellar or dark room, in rooms where only diffused light and no direct sunlight is present, and in open-air plats where the sunlight is unobstructed. If plants are grown in beds somewhat shaded by being covered with colored glass, we find that the growth of the plants is less than the growth of those grown in ordinary sunlight, so far as perfect development is concerned. If we compare plants grown in the dark with the same kinds of plants grown in sunlight, we find that their stems are longer and more slender than the latter. From this it is seen that light has a retarding influence on the elongation of the stem. In general we may say that the action of light on plants is manifested in the following ways:

- (1) In the elongation of the stem;
- (2) the direction of the stem;
- (3) heliotropism, or the tendency of the plant to direct its stem and growth towards the source of light (This is very marked in the sunflower; in the morning its leaves and flowers are directed towards the east and in the afternoon they are directed westward to the sun.);
- (4) diaheliotropism, or the tendency of leaves of some

plants when exposed to the open lighted sky to assume a horizontal position or one at right angles to the source of light (The leaves of plants in the house having a side illumination only are usually turned with their upper surfaces toward the source of light or perpendicular to the incidence of the rays of light.); (5) the arrangement of the leaves in rosette form as seen in peppergrass, sow thistle, English plantain, strawberry, common thistle, mullein, and the dandelion.

Variation by Pruning. — An example of what may be accomplished in the way of variation through pruning is found in the origination of the Burpee Bush Lima Bean. Professor Bailey in *Plant Breeding* relates the following incident: About 1883 a Mr. Palmer had practically his entire crop of white pole Lima beans destroyed by cutworms. But one little plant out of this number, which had been cut off about an inch above the ground, put out a new growth, and finally developed three pods, each containing one seed. The following year these were planted and two dwarf plants resulted, from which was finally developed the bush Lima bean as we have it to-day. This suggests that other plants may likewise undergo considerable variation under pruning and care.

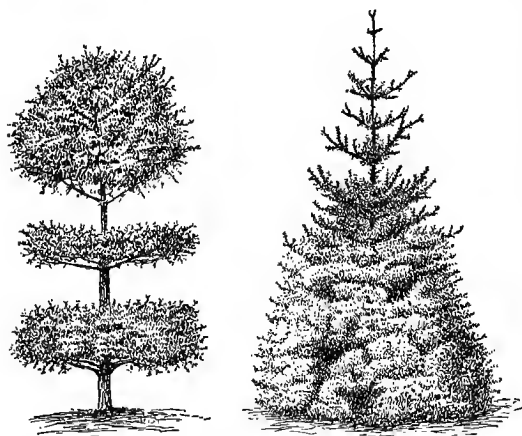
Object of Pruning. — According to Professor Bailey the objects to be sought in pruning are: (1) to modify the vigor of the plant; (2) to produce larger and better fruits; (3) to keep the plant within manageable shape and limits; (4) to regulate the quantity of fruit borne by the plant, (5) to remove injured limbs or superfluous parts; (6) to facilitate spraying and harvesting; (7) to facilitate cultivation; (8) to make the plant assume some desired form.

Method of Pruning. — A great deal of injury is often done to trees by careless pruning and improper treatment of the resulting wounds. When the limb is to be removed entirely, it should be sawed or cut off close to the body of the tree so that no projecting stub will be left to prevent the proper healing of the wound. When the stub is left, it causes the bark to die around it, and in course of time when the stub rots out a cavity will be left in the tree in which insects or plant growths will lodge and eventually injure the tree. When decayed places are found in trees, it

is best when possible to clean such places thoroughly and then fill them up with Portland cement.

After carefully smoothing off the surface of a wound left by removing a large limb it is sometimes advisable to apply a dressing of pine tar, grafting wax, or lead paint. Where only a portion of a limb or branch is to be removed, it should be cut off just above a bud or node. In each case care must be taken not to cut too close to the bud or too far above the bud.

Perhaps the least injurious method of pruning, so far as the plant is concerned, is the prevention of the formation of new branches or shoots by pinching or rubbing off the buds which would form such growths. If the terminal bud is removed, more growth will be made in the lateral branches and the plant will become bushy.



Avoid stilted effects.

Trimming or pinching off the lateral buds will throw the growth into the terminal bud making the central stem elongate more rapidly.

Another method of pruning is what is known as root pruning. This tends to check the production of wood, and when carried out properly may

increase the fruitfulness of the tree. In healthy plants there is usually an even balance between leaf surface and root surface. Root pruning is done by cutting in a circle around the tree in line with the outer tips of the branches, but this will vary with the particular plant under treatment and the nature of the season when the pruning is attempted.

In pruning the limbs of shade or ornamental trees it is always best to avoid stilted and unnatural effects in the shapes that are designed. Evergreen trees look much prettier when left untrimmed.

Time for Pruning. — When branches are partly broken off by storms or accident, they should be removed at once. Dead or diseased branches should also be promptly cut off as soon as discovered, regardless of the season. General pruning should be done while the trees are in the dormant state, either in the fall or spring.

If the pruning is done in the spring, the wound heals readily, but there is a waste of the plant's energy in the loss of the accumulated food supply by the removal of the terminal portions of the branches. Spring pruning lessens wood production and induces fruitage.

If the pruning is done in the fall, the wound does not heal readily and may become diseased, but on the other hand many immature branches that would be killed by hard freezing in the winter would be removed and the vigor of the plant improved thereby. Late fall or winter pruning always favors wood production.

In transplanting trees, whether in the fall or early spring, it is always best to prune them rather closely. A great many of the roots are injured and broken in digging up the tree, and pruning of the branches is absolutely necessary to equalize its leaf and root surface. It will also reduce the amount of surface exposed to the action of the wind so that the tree will not be blown down or moved out of place.

Variation by Cross Fertilization. — Many plants produce flowers which are self-fertilized, but the resulting offspring in many cases is not so strong and vigorous as when the flowers are fertilized by the pollen of another plant. If both plants are of the same kind, the resulting offspring is called a cross; but if the plants are of different kinds, as a raspberry and a blackberry, the offspring is called a hybrid. Hybrids and crosses are generally different from both parents, but often combine and emphasize some of the good qualities of each. By repeating this process a number of times with flowers of carefully selected individuals we may eventually originate a new plant and make it a permanent type. In planting the resulting seed we frequently find that the offspring do not come true to the seed and that there is a tendency to revert to the original or ancestral type. Constant vigilance and enduring patience alone will insure success.

Bud Variation. — Sometimes a certain branch of the tree will show marked and desirable characteristics which may be propagated by transferring its buds to other kindred plants. The nectarine with its smooth skin as well as its delicious flavor resulted from a bud variation of the peach. Choice varieties of peaches, plums, apricots, pears, apples, roses, and many other kinds of plants have been secured through bud variation.

The Law of Heredity. — Variation is the starting point of plant improvement, but the production of any new plant is of no value if its characteristics cannot be transmitted to its offspring. The general law of heredity is that "Like begets like"; for example, corn produces corn and not some other kind of grain. According to this law we also expect the offspring to a certain extent to show the same general and special characteristics as are found in the parent plant. Thus a bitter orange will produce bitter oranges, sweet corn will produce sweet corn, bearded wheat will produce bearded wheat. We have already learned how Mr. Fultz discovered a few heads of beardless wheat in his field of bearded wheat and how by planting the grains of these heads he was able to produce and propagate a new variety of wheat. But for the *law of heredity* his discovery would have been of no value since the new species could have not been propagated.

Selection. — In going through a field of corn we find that some stalks have put all their growth in the stalk and blades and have produced small ears of corn; one, perhaps, has only a single large ear while another has produced two or more large ears. In some cases we may find that the ear has a large cob and the grains are small, and in other cases we may find large grains and small cobs. If we are growing corn for the purpose of securing large and perfect cobs, we select seed corn from ears having large cobs. In Missouri and some other States cobs are used for making corn-cob pipes, and the cobs are more valuable than the corn itself. Hence in the vicinity of these cob pipe factories farmers select their seed corn with reference to the cob only. By careful selection from time to time some farmers have succeeded in raising a variety of corn having large ears with large cobs and fairly good-sized grains. In the majority of cases farmers live in communities where the cobs have no particular commercial value and conse-

quently select their seed corn solely with reference to the grain and the stalk. It is not a good plan to select the seed from corn in the crib, as is frequently done, but it is best to go to the field and make the selection from the growing stalks of corn. The plant must be considered as well as its product. Not only must we have a good ear of corn to select our seed from, but we must know that the stalk on which it grew was able to produce more than one ear of the kind that we use for seed. If we follow this plan from year to year, the yield per acre will be increased, while the amount of work spent in cultivation will be no greater. Not only shall we be able to increase the yield, but we shall be able to produce new varieties.

A notable instance of the effect of selection is seen in the development of sugar beets. Some of the first beets that were grown had only approximately 8 per cent of sugar, but by selecting each year the seed from the sweetest beets a new variety was finally developed which had from 18 to 20 per cent of sugar. The

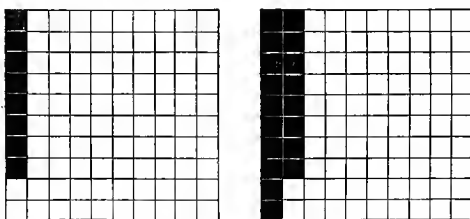


Diagram of increase of sugar in beets produced by selection.

test is made by inserting a *trier* in a slanting direction from the shoulder of the beet and extracting the core of the root. The juice of this core is analyzed, and the beets showing the highest percentage of sugar are kept for the production of seed. After removing the core the hole in the root is filled with charcoal, clay, or cotton dipped in formalin to prevent decay. Sugar production from beets dates back to 1747 in Austria in the Old World, but in the United States continuous attempts have been made since 1863. California, Colorado, Michigan, and Utah are our chief beet sugar producing States. The total annual production of beet sugar is about two hundred thousand tons.

EXERCISES

1. Plant a few radish seed in two tomato cans of sand. Label the cans A and B. Keep both watered and supply B with fertilizers. Note results and explain.
2. Fill six match boxes or chalk boxes partly full with rich moist soil.

Plant the same kind of seed in each box. Cover the first box with red glass, the second with blue glass, the third with green glass, the fourth with yellow glass, the fifth with brown glass, and the sixth with clear window glass. Put the boxes where they will have free access of sunlight and air. Note the results and explain.

3. Plant seed in three boxes. Place the first one in the cellar or in a dark room, put the second one in a well-lighted room, but keep the plant in the shade, and put the third one outdoors where it can have plenty of sunlight and air. Note results in the growth of the stems and explain. Also note the color of each of the three plants and explain.

4. Make experiments in pruning on tomato plants, peas, beans, and other plants.

5. Prepare grafts of various kinds.

6. Illustrate budding.

7. Test seed for vitality and purity.

QUESTIONS

1. Discuss the origin of domestic plants.
2. On what three things does plant improvement depend?
3. Discuss the effect of change in the food supply.
4. What effect on the plant has (a) the supply of light? (b) the kind of color of light?
5. Discuss (a) heliotropism, (b) diaheliotropism.
6. Discuss variation produced by pruning.
7. Name the objects of pruning.
8. Describe the proper method of pruning.
9. Discuss root pruning.
10. Discuss the proper time for pruning.
11. Explain variation due to cross fertilization.
12. Discuss bud variation.
13. Discuss the law of heredity.
14. Explain the method of selection.

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XXVII. FRIENDS AND ENEMIES OF PLANTS

THE struggle for existence among plants is no less strenuous than it is among animals. The friends and enemies of cultivated plants are numerous, but in general they may be divided into the following groups: (1) plant forms, (2) animal forms. Each of these may again be subdivided as follows:

1. Plant Forms	{	I. Fungi	{	1. Molds
			{	2. Bacteria
			{	3. Yeast
	{	II. Weeds	{	1. Annuals
			{	2. Biennials
			{	3. Perennials
2. Animal Forms	{	I. Insects	{	1. Biting or Chewing Insects
			{	2. Sucking Insects
			{	3. Predaceous Insects
	{	II. Birds	{	1. Harmful Birds
			{	2. Beneficial Birds
		III. Animals	{	1. Harmful Animals
			{	2. Beneficial Animals

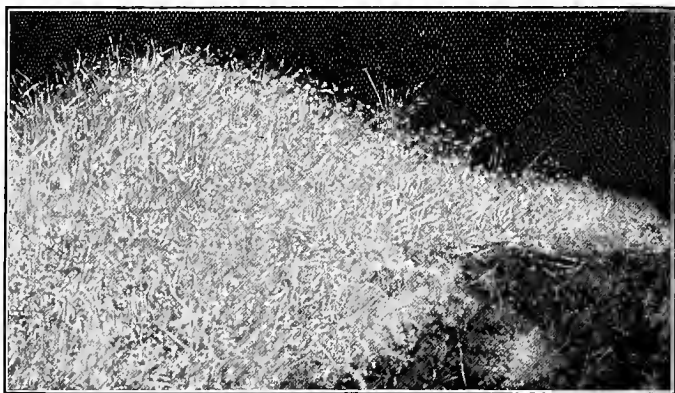
1. PLANT FORMS

Fungi. — We have all noticed the molds that form on bread, cheese, fruit, and other articles when left exposed to the air for some time. If we examine these molds with a microscope, we find that they are very minute plants which do not contain chlorophyll, and this compels them to depend upon other organisms for their supply of food. This food they may obtain in two ways: either (1) directly from living plants and animals, or (2) from organic waste products or dead bodies. The former are called parasites and the latter saprophytes. Some species, however, may live either as parasites or saprophytes as necessity may demand. If it were not for the saprophytes, the whole earth would soon

become covered with a heavy deposit of the remains of the dead plants and animals of past generations. These little plants that live on other plants or animals and obtain their nourishment from them are called fungi, and each separate plant is called a fungus. Because of having no chlorophyll they are never green, but are usually white, pink, yellow, brown, or blue. Fungi do not propagate by seeds but by spores. These are minute bodies or cells which correspond to the seeds of the higher plants and require the same conditions for germination. These spores reproduce with such wonderful rapidity that one plant may produce several million in a single day.

The classes of fungi are: (1) molds, (2) bacteria, (3) yeast.

Molds. — If damp bread is set away for a few days under a glass cover, we notice that a furry growth is forming, which bota-



Mold growing on bread.

nists call mold. It may also be frequently seen on the surface of canned fruits, preserves, manure heaps, etc. Slices of lemon when left exposed for a few days will also develop what is generally called blue mold. Sometimes we may see this same blue mold on apples where the skin has been broken or bruised. In the course of a short time this mold causes the apple to rot. This same mold, when it comes into contact with bruised or exposed places in other apples, will attach itself and cause decay to begin in a very short time. From this we see that diseases may be transmitted from

one apple to another, and hence the necessity of removing at once all apples affected with rot. If we apply some mold with a match or nail to a clean, damp piece of bread and in lines or rows across the bread, we find that in a little while the mold begins to appear in these rows.

Bacteria are very minute plants so small that more than 1500 of them would be required to reach across an ordinary pin head. Some of them are harmful, some produce decay and disease, while others are beneficial. Those which cause diseases are often called microbes or germs. Many bacteria, however, are of great value to us and assist in the digestion of our food. Millions of bacteria are present in the air we breathe, in the water we drink, and in the food we eat. They also inhabit the bodies of both plants and animals.

With reference to structure bacteria may be divided into three classes or forms: (1) spherical bacteria, which are one-celled organisms grouped in various ways; (2) rod-shaped bacteria, in which the cells lie end to end, either attached or unattached; (3) elongated bacteria, in which each bacterium is an elongated cell and is curved somewhat like a comma or a spiral.

Bacteria reproduce themselves by cell division in fifteen to forty-five minutes, and may repeat this operation continuously. Many of them are able to withstand long-continued dry weather or extreme cold. It is said that the bacterium of typhoid fever may become quite active again after being frozen in ice for several months. The only safeguards against such bacteria are to boil all the water we drink and to cook well all the food we eat.

With reference to their relation to animals and plants, bacteria may be grouped under the following heads: (1) agents of fermentation, (2) agents of disease, (3) agents of nitrification.

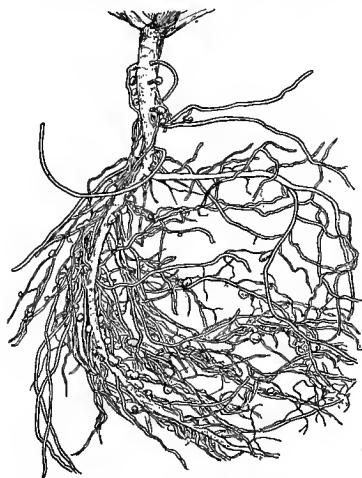
Agents of Fermentation.—These are the bacteria that aid in the manufacture of vinegar and cause the souring of milk and various fruit juices. They also cause decomposition of organic matter in the soil and are very important in relation to soil fertility.

Agents of Disease.—Among animals these bacteria produce diphtheria, typhoid fever, cholera, pneumonia, consumption or tuberculosis, and other kindred diseases. Among plants they produce many diseases, such as pear blight, apple blight, crown gall

of peaches, apples, etc. They are readily passed from one plant or animal to another.

Agents of Nitrification. — The bacteria in the soil are the chief means of making nitrogen available to plants. One kind seem to have the power of taking the free nitrogen in the soil air and fixing it in the form of solid compounds. Another kind gather nitrogen from the air through their relation to the roots of certain kinds of

plants known as legumes or nitrogen-gatherers such as alfalfa, clover, peas, beans, and the like. The nitrogen is stored in tubercles on the roots.



Nodules on roots of red clover.

Yeast. — We have all learned something about yeast from observing its use in making bread, but, perhaps, if we were called upon to say whether yeasts were plants or animals we should hardly know what opinion to express. Upon close examination we find that yeasts are one-celled plants which play an impor-

tant part in certain kinds of fermentation employed in the making of bread and in the manufacture of beer, wine, and spirits of various kinds. In this process the sugar is broken up into alcohol and carbon dioxide. The latter, expanding under the influence of heat, puffs up the pores of the dough and makes it rise. Were it not for the action of this gas our bread would be heavy and unfit to eat. These same little plants acting on the sugar in cider and sweet wine set up fermentation and cause them to sour. If we place a little yeast in sweetened water, in a little while we notice bubbles of gas escaping; and if this be collected and tested, we find that it is carbon dioxide. Yeast plants reproduce themselves by budding.

Fungous Diseases. — The various diseases caused by the presence of fungi are usually designated as fungous diseases.

Some of the most common forms are the fire blight of the pear and apple, smut, rust, rot, wilt, potato scab, potato blight, peach leaf curl, apple scab, club root, black knot, and other kindred diseases.

Fire Blight. — Frequently we find twigs on our apple or pear trees which look black as if they had been charred by fire and the leaves upon these twigs also are blackened and withered. This disease is caused by the presence of bacteria in the juicy part of the stem between the bark and the hard wood. These bacteria are carried from tree to tree at blossoming time by insects as they flit from flower to flower. As soon as the diseased twigs are discovered they should be cut off and burned without delay. It is best to cut the twig off about ten or twelve inches below the affected part, and as an additional precaution the pruned stub should be thoroughly disinfected by swabbing with a sponge soaked in a dilute solution of corrosive sublimate, one part in one thousand of water.

Smut infests cereals and is especially noticeable on oats and wheat. The smuts of these two plants, however, are entirely distinct. The spores of the oat smut fungus are lodged under the seed coat and infect the young oat seedling when two or three days old. This disease may be controlled by soaking the seed oats for an hour with formalin diluted at the rate of one pint in fifty gallons of water. The wheat smut fungus gains entrance to the seed at the blossoming time and lies dormant in the kernel over winter. With the growth of the plant the fungus causes a smut of the head. Formalin is not effective except in strengths which would kill the germ of the grain. A hot-water method of treatment has been devised.

Rust. — One of the most common forms of this disease is what is known as apple rust. This fungus uses the red cedar as its winter host and causes the so-called cedar apple. In wet weather jellylike tentacles or arms form on these cedar apples which contain millions and millions of spores. In dry weather they float off in the form of a dust or powder through the air and lodge on the foliage of the apple tree. In a short time the leaves become covered with orange-colored spots and wither away. The only satisfactory remedy is to remove all cedar trees from the vicinity of the orchard.

The Brown Rot of Stone Fruits. — This is a common disease of the plum, peach, and cherry which spreads very rapidly in warm, moist weather. It begins as a small dark brown spot on the partially ripened fruit and gradually spreads all over it. The fruit finally dries up and forms a mummy which generally hangs on the tree all winter. These mummies contain millions of the dried spores which, if not destroyed, will affect the fruit the following year. They should be shaken off and destroyed by burning or fed to hogs. The tree should be sprayed in summer with self-boiled lime-sulphur made of 8 pounds of stone lime, 8 pounds of sulphur flour, and 50 gallons of water.

The Black Rot of Grapes. — This disease begins as a purplish brown spot and gradually spreads over the grape, which finally shrivels up and turns black. The Bordeaux solution is effectively used, but because of its staining the fruit the following mixture is preferable for spraying nearly mature fruit:

Copper Carbonate	5 oz.
Strong Ammonia	3 pt.
Water	50 gal.

At first use only water enough to make a thin paste, then put in the ammonia and mix thoroughly before adding the remainder of the water.

The Bordeaux solution is made up as follows:

Copper Sulphate — Blue vitriol	5 lb.
Unslaked Lime	5 lb.
Water	50 gal.

Bitter Rot of Apples. — This is a disease that usually does not affect the fruit until it is nearly ripe or fully matured. It generally appears as small brown spots which gradually unite and cause the fruit to rot. All apples affected with it should be destroyed. Its ravages may be checked by the use of Bordeaux mixture.

Apple Scab. — This disease attacks both fruit and foliage, forming sooty spots on the leaves and brownish scabs on the fruit. Use the same remedies recommended for black rot.

Peach Leaf Curl. — This is a disease which causes the leaves to curl and twist up until they turn dark and fall off. The fruit shrivels up and cannot be used. The damage resulting from it

annually in the United States is estimated at \$3,000,000. It may be checked by spraying with the Bordeaux mixture before the buds open.

Wilt is a disease caused by a soil fungus which enters the plant through the roots and forces its way upward into the stem, and chokes the ducts or passages and shuts off the flow of the sap from the roots to the leaves and branches of the plants. The water supply being shut off from the leaves, they soon wilt and wither away. The plants most commonly attacked by wilt are cotton, flax, tobacco, and cowpeas. It may be remedied by frequent crop rotations and by selecting wilt-resistant varieties of these plants.

Potato Scab. — Potatoes are often covered with a rough coating of scabs caused by a fungous growth which starts on the surface. It may be checked by soaking the seed potatoes in a weak solution of formalin, one half pint with fifteen gallons of water, for two hours or more. The same solution may be used several times. Treated potatoes must be planted in clean soil, that is, soil free from scabby tubers from previous years.

Potato Blight is a disease which attacks the leaves of the potato and rapidly extends its ravages until it completely destroys the plant. Its presence is generally heralded by the appearance of brown spots upon the margin or body of the leaf. It also causes a rot of tubers. The best remedy is spraying with the Bordeaux mixture to which a little Paris green has been added.

Club Root is a disease of the cauliflower, cabbage, and turnip which causes an undue enlargement of the roots of each of these plants. It may be prevented by a liberal addition of lime to the soil.

Black Knot is a contagious disease which attacks the branches and twigs of both sour cherry trees and plum trees and brings on decay and death. The most satisfactory remedy is to cut out all branches affected and burn them in January before the growing season commences.

Weeds. — In a general way we all have the same idea of what is meant by weeds, but sometimes we find it hard to make a proper distinction between them and ordinary plants. All plants out of place or that persist in growing where they are not desired

are classed as weeds. Thus our ordinary white clover when growing upon our lawns might be classed as grass, but when found growing in the garden in our onion or lettuce bed would be classed as a weed. Many of our present cultivated plants were once wild plants, but have been improved by cultivation and selection until they have been brought up to their present state of perfection. It is also possible that many other plants which we now regard as useless weeds may be found to have some useful property

and may sometime be classed among our valuable cultivated crops.



Burdock.



Cocklebur.

Good farming involves the control of weeds. Some of the most effective means of control are: good rotation courses; clean tillage; cleaning up of waste places in which weeds *breed*; care in the choice of clean seed; care to see that the manure does not carry seeds; alertness to recognize new weeds when they begin to invade the neighborhood.

Why we should prevent the Growth of Weeds. — There are many reasons why we should not allow weeds to obtain a foothold among our crops; some of them may be briefly stated as follows:

1. Their numbers will increase from year to year, and much labor will be required to eradicate them.

2. They appropriate the nourishment of the soil and diminish the supply needed by our cultivated plants.

3. As they make a rapid growth they shade the ground and may shut out warmth and sunlight much needed by the plant.

4. When abundant they shut off the ventilation and soon smother out the smaller plants.

5. They rapidly deplete the supply of moisture in the soil, which should be reserved for the cultivated crop.



Canada thistle.



Sow thistle.

6. It is thought that many diseases of both plants and animals are caused by the presence of luxuriant growths of certain obnoxious weeds.

7. Weeds are frequently injurious and even poisonous to stock. Both cattle and horses are frequently killed by eating the loco weed, while every one is familiar with the fact that wild

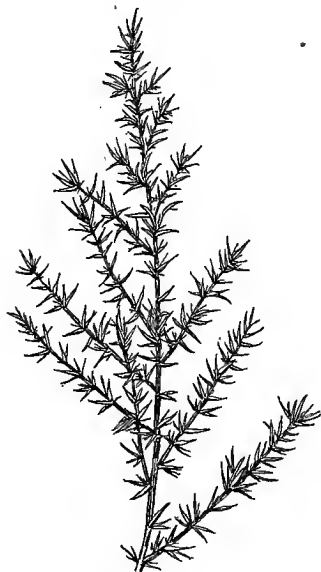
onions and ragweeds when eaten by cows taint their milk and make it undesirable for use.

8. Weeds generally afford a natural harbor for dangerous reptiles and injurious insects, which have their breeding grounds in such places.

9. Weeds shade our fences and hasten their decay.

10. Weeds suggest carelessness and neglect.

Are Weeds ever Beneficial?—If your instructor should ask you whether weeds were ever beneficial, perhaps you would not hesi-



Russian thistle.



Quack grass.

tate to say no, but your answer would not be strictly correct. Sometimes farmers find it of some advantage to let a field rest and grow up in weeds under certain conditions. Before the weeds mature or get too large they are plowed under and thus form a rich manure for the soil. The weeds also shade the ground and prevent it from baking.

Kinds of Weeds.—There are three general classes of weeds: (a) annuals, (b) biennials, (c) perennials.

Annuals grow, mature their seed, and die within a year. Among these are the ragweed, cocklebur, horseweed, burgrass, dog's fennel, wild lettuce, Russian thistle, pigeon grass, etc. Annuals may be held in check by frequent tillage and by preventing them from seeding. In an open, uncultivated field they may be mowed or pastured with sheep. They follow tilled crops.

Biennials do not finish their growth and mature their seed until the end of their second year. The most troublesome ones are the wild carrot, the bull thistle, and the burdock. They can be checked by grubbing them out or plowing them under from time to time.

Perennials grow from year to year, and many of them are reproduced both by running roots and by seeds. These include



Oxeye daisy.



Long-leaved plantain.

quack grass, sow thistle, Canada thistle, dandelion, horse nettle or sand brier, nut grass, white daisy, English plantain, sour weed, wild onion, etc.

Perennials are very difficult to eradicate, and they have to be fought in many ways. Constant and clean cultivation will do much to subdue them, but sometimes farmers have to smother out the weeds by sowing some crop that makes a quick, heavy, luxuriant growth. Cowpeas are often used for this purpose and prove quite satisfactory. These weeds must not be given a start.

EXERCISES

1. Secure and name ten common weeds of your locality. Tell where you found them.
2. Examine the fruit trees closely and report what diseases are found.
3. Secure specimens of mold, and examine them with a microscope.
4. Secure specimens of yeast and examine them with the microscope.

QUESTIONS

1. Into what two great classes may the enemies of cultivated plants be divided?
2. Give the divisions and subdivisions of the first class, and also of the second class.
3. Describe the fungi in general.
4. Discuss (a) mold, (b) yeast, (c) bacteria.
5. Discuss (a) agents of fermentation, (b) agents of disease, (c) agents of nitrification.
6. Describe yeast.
7. Discuss (a) fire blight, (b) smuts, (c) rust.
8. Discuss (a) brown rot, (b) black rot, (c) bitter rot.
9. Describe (a) the apple scab, (b) the peach leaf curl, (c) the wilt.
10. Discuss (a) potato scab, (b) potato blight.
11. Describe (a) club root, (b) black knot.
12. Discuss weeds.
13. Why should we check their growth?
14. Are weeds ever beneficial?
15. Name the three general classes of weeds.
16. Describe some of the special weed forms.
17. If the loss caused by weeds is fifteen bushels of corn to the acre, what will be the loss on twenty acres if corn is worth forty cents per bushel?
18. If the corn is too thick in a field, is it not its own worst weed?
19. What weeds are most common on the farms near the school? Ask farmers what they are doing to control them. Find which ones have few weeds in their crops. Are they the most thrifty farmers? Why have they fewer weeds?

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XXVIII. FRIENDS AND ENEMIES OF PLANTS—*Continued*

2. ANIMAL FORMS

Insects. — If you were called upon to name some animals that are classed as insects, you might mention ants, flies, bugs, beetles, butterflies, and moths; but at the same time you might wonder why they are all grouped together when some of them differ so much from one another. A little study will show us, however, that they have this much in common. They have six legs, and their bodies are divided into three parts—the head, the thorax, and the abdomen. They breathe through tiny holes, called spiracles, arranged in a row along each side of the abdomen. On the head are found the mouth, eyes, and the antennæ.

Such insects as the butterflies, bees, houseflies, and beetles, pass through four stages before they reach maturity: the first is the egg; the second, the larva; the third, the pupa; and the fourth is the adult, or imago.

The tiny egg is deposited in some safe place where, after a certain time it hatches out into the larva state, in which it becomes a worm-like creature so different from the original insect that we should hardly suspect that there was any relationship between them. This is also frequently called the grub or caterpillar stage. While in this state they eat almost continually and do a great deal of damage. Finally it enters the pupa stage and eats nothing. It goes into a kind of sleep, and while in this condition it gradually changes into a fully developed insect. This last stage we call the imago. Some insects do not pass through all these stages, as in the case of the locusts and grasshoppers.

Insects do a great deal of injury, but we must not regard all of them as troublesome pests. The honeybees furnish us with food in the form of honey, the silkworm supplies us with silk and materials for clothing, while some insects do us valuable service by carrying pollen from one flower to another and causing flowers to be fertile which might otherwise remain sterile.

Groups of Insects.—So far as the insect pests of agriculture are concerned we may make two general groups: (1) biting and chewing insects, (2) sucking insects.

Biting Insects.—This group includes all insects in which their mouth parts are formed for biting and chewing. They bite off, chew, and swallow the leaves or other portions of the plant upon which they happen to feed. Common examples of this class are to be found in caterpillars, grasshoppers, beetles, cotton boll weevil, etc. On account of the manner in which these insects secure their food they may be killed by spraying the plants with poisonous solutions.

An effective spray may be made as follows:

Scheele's Green	1 lb.
Quicklime	1 lb.
Water	100-300 gal.

In applying this solution it must be kept well stirred. Paris green may be substituted for Scheele's green, but it is more costly and often burns the foliage of plants.

Another good spraying solution is prepared in this way:

Arsenate of soda	4 oz.
Acetate of lead	11 oz.
Glucose	2 qt.
Water	25-100 gal.

Dissolve the acetate of lead in a bucket of warm water and mix it with the arsenate of soda, which has been previously dissolved in another bucket of warm water. Use wooden buckets because these chemicals will corrode vessels made of tin or other metal.

Sucking Insects.—This group includes all insects in which the mouth parts are adapted for sucking rather than for biting. Since these insects secure their food from the juices of the plant and not from the surface, it is evident that spraying the plant with poison would do no good. In this group are the squash bug, chinch bug, green bug, plant lice, mosquitoes, flies, San Jose scale, and other scale insects.

The only sprays that are effective with this class of insects are those that corrode the body of the insect, and those that penetrate the breathing pores of the insect and produce suffocation.

The following emulsion is highly recommended:

Soap	.	.	.	.	.	$\frac{1}{2}$ lb.
Soft water	.	.	.	.	.	1 gal.
Kerosene	.	.	.	.	.	2 gal.

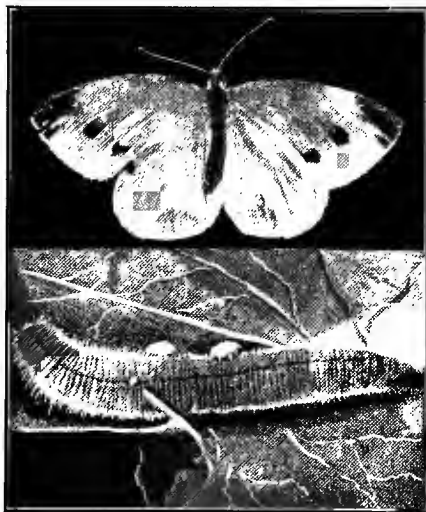
Shave the soap into the soft water and bring to the boiling point. When the soap is dissolved, pour in the oil and agitate vigorously until a white, creamy emulsion is formed. When ready to use, add seventeen gallons of water and spray the solution on the bodies of the insects to be killed.

Sprays of tobacco, tea, pennyroyal, or volatile oils sometimes are found very satisfactory. In other cases tobacco smoke and fumes or poisonous gases are found effective. Fumes from hydrocyanic acid are frequently used in treating San Jose scale. In bins and seed chests carbon bisulphide may be used to good advantage if these receptacles are air-tight, but this liquid is very inflammable and must be kept away from the fire. Ant beds may be broken up by repeated applications of carbon bisulphide and gasoline. Bear in mind that gasoline is very destructive to all kinds of vegetation with which it comes in contact.

Soft-bodied insects may frequently be killed by applications of lime or wood ashes, which should be carefully dusted over the infected plants. Sprays of very dilute carbolic acid are also helpful in such cases.

Predaceous and Parasitic Insects. — These are in-

sects that prey upon other insects. Among these may be mentioned the ladybugs, which feed on plant lice and scale insects. The Chinese ladybugs and the Australian ladybug have been used largely in California to



Cabbage butterfly and larva.

check the ravages of the San Jose scale. Tiger and ground beetles devour hundreds of cutworms and caterpillars. Dragon flies live in the vicinity of ponds and streams and feed on gnats, flies, and mosquitoes. Some of the ichneumon flies kill fruit-tree borers, tentworm caterpillars, and cabbage worms. One variety has been found in Spain that feeds on the codling moth.

The much despised red wasps and yellow jackets prey upon flies and the larvæ of the boll weevil. Some varieties of ants also prey upon the boll weevil.

The Plum Curculio. — The adult is one of the snout beetles; it deposits its egg in the fruit and then surrounds each egg with a crescent-shaped cut to check the growth of the fruit so that the egg will not be crushed. The larva eats its way deep into the fruit and causes it to fall to the ground. The larva then bores into the earth, where it remains for a few days, when it comes forth as an adult weevil, or beetle that lives over the winter. At this stage the beetles may be killed by spraying the trees with poison. Farmers also spread sheets of canvas under the affected trees early in the morning, and by shaking or jarring the trees vigorously most of the beetles will fall off, and then may be collected and burned with a little straw.

The potato beetle is a striped beetle which lays its eggs on the potato plants. In a short time they hatch into reddish colored grubs, which immediately begin devouring every potato leaf within their reach. It is estimated that each female will produce six hundred to one thousand eggs, and these develop into full-grown beetles within five or six weeks. Two or three broods are hatched every season, and when they finish their depredations there is usually but little left of the potato plant. Spraying with poison and hand picking seem to be the only satisfactory remedies.

The chinch bug is a small, insignificant looking bug which attacks wheat and corn principally. Chinch bugs usually begin on the wheat, oats, and other small grain, and after these are harvested they begin to attack the growing corn. Several remedies have been proposed, but nothing satisfactory has been found thus far. Some farmers burn over their stubble fields and burn up all trash that might afford shelter to the bugs. If proper precautions are

taken to destroy all rubbish in which the bugs hide away to pass the winter, much will be accomplished towards getting rid of them. Frequent change of crops will also be helpful.

The cankerworm is a common measuring worm. It is usually green or brown and is the larva of a moth. Cankerworms eat ravenously, and in a short time can clean up the foliage of every tree in the orchard. The tree may be protected against the female moth by wrapping a piece of gummy or sticky paper or cloth closely around its trunk.

The army worm is the larva of a common moth and is one of our most destructive pests. These worms are called army worms because they move about in vast numbers like a destroying army, devouring all vegetation that lies in their path. They are hard to combat successfully when they make their appearance in a field. Farmers frequently plow an extra deep furrow around the field in order to trap them in their onward march. This ditch is then partially filled with straw and a torch is applied. As the straw burns a great many of the army worms that are imprisoned in the ditch are burned and destroyed.

The Tent Caterpillar.—The apple-tree tent caterpillar is a destructive pest with which every farmer is more or less familiar. The parent moth lays her eggs in the form of a girdle around a twig in the summer, and in the following spring these hatch into greedy caterpillars which strip the leaves of the tree as they move from twig to twig. They spin a web or tent, generally in the forks of some branch, and this affords them a shelter at night.

They may be held in check by our destroying their eggs in the winter, by burning their nests, by spraying the foliage with arsenate of lead or Paris green, and by encouraging the residence of cuckoos, blue jays, crows, orioles, and other birds that feed upon these caterpillars.

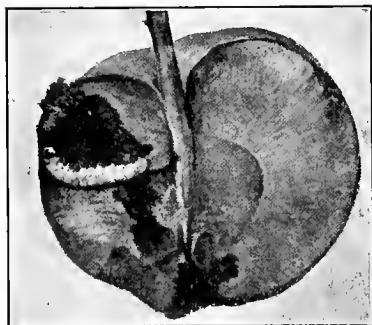
The tobacco worm is the larva of the sphinx moth, and is very destructive in its ravages on the tobacco plant. The worms are usually picked by hand from the plants and destroyed. The moth is very fond of the blossoms of the Jimson weed, and if a little cobalt mixed with sirup is placed in such blossoms the moth is easily poisoned.

The currant worm is the larva of the sawfly. The larvæ hatch

out from eggs laid end to end along the veins on the under side of the leaves of the currant bush.

The cotton-boll weevil is a pest that came originally from Mexico to Texas, and from this State it has worked its way into Louisiana, Texas, Arkansas, and Oklahoma. It is a small, reddish brown snout beetle which breeds in the cotton pod and feeds upon the plant. The female beetle deposits her eggs in a cotton square or in a boll. In a short time the eggs hatch out into grubs, which in the course of a month become mature beetles. It is estimated that each beetle will produce about one hundred eggs during her lifetime. All cotton squares affected by them usually drop to the ground, while the bolls become stunted and stop growing. The ravages of the boll weevil may in some measure be checked by burning up all trash and stalks of the field in the fall so that the weevils will be deprived of a winter home. It is also advisable to secure a weevil-resistant variety of cotton which should be planted early and should be well cultivated. Poisoning with Paris green has been tried, but has not been found satisfactory. The Guatemalan ant has been introduced into Texas with the hope that it might destroy the boll weevils, but the results have been disappointing. Certain native ants are much more efficient enemies of the weevil.

Cutworms are the larvæ of several different kinds of moths, which usually feed at night. They cut tender young plants off at the surface of the ground. They may be brown, gray, or green. Early and frequent cultivation of the soil will reduce their number largely. January plowing is especially recommended in the Southern States. Rotation of crops will also be found helpful.



Larva of codling moth.

The codling moth is a pest that preys upon our apples and causes the loss of millions of dollars annually to our farmers.

The moth lays her eggs on the young apple and on the leaves of the tree. These eggs hatch into worms, which eat their way

into the fruit and cause poor, wormy apples. To keep this pest in check, spray the trees with arsenate of lead, three pounds to fifty gallons of water, once just after the petals fall, once again in ten days, and a third time three weeks later. Never spray with a poison while the tree is in bloom.

The Hessian fly is a small insect that lives on the stems of spring and winter wheat and causes great damage. It is a good plan to burn over the stubble after harvest and to destroy all trash and rubbish. As a further protection against the Hessian fly it is also generally advisable to delay sowing fall wheat until the weather becomes cool enough for frost.

The San Jose scale is a small insect, but it is one of the most destructive pests of fruit trees now known. The adult females are much smaller than a pin head, but they occur in such large numbers that they soon cover the bark of the tree and cause death. Sprays of kerosene and fumigation with hydrocyanic acid gas are used to check this insect. A solution made by boiling lime, salt, and sulphur together is likewise said to be a very good remedy. It is generally a good plan to cut down and burn all trees on which the scale makes its appearance. In some States this has been made obligatory upon fruit growers, and heavy penalties have been prescribed against those who fail to observe and keep the law.

Birds.—Many farmers unjustly look upon birds as a nuisance and do not stop to consider the great service they render man. Birds are being killed by the hundreds every year, not only to gratify the whims of inconsiderate hunters, but also to supply the demands of milliners, who use them as decoration for ladies' hats, etc. Boys ruthlessly collect and destroy hundreds of eggs every year, and it is almost impossible to estimate the number of young birds that are caught and devoured by cats.

Sometimes we hear the complaint that birds destroy a great deal of fruit, and in some instances it may be true; but the reason and the remedy are not hard to find. It is usually during a dry season that birds attack fruit the most, and then it is only the juice of the fruit that they seek as a substitute for water. If we only take the precaution to place cans or pails of water in several places convenient to the birds, and give them some of the bread

crumbs and scraps that usually are thrown away, we may find that the birds will destroy but very little of our fruit. On the other hand, birds feed largely on insects and thus help to check the hordes which would otherwise destroy the fruit crops.

The birds are our friends, and we should use every possible means to show our appreciation of them. When trees are not at hand in which they may nest, we should provide suitable bird houses and shelters for them. The tin cans which so often go to the waste heap, when nailed on boards or the side of the barn make very good and inexpensive bird houses.

Harmful Birds. — There are only a few birds that may be classed as harmful or injurious. The sharp-shinned hawk, goshawk, Cooper's hawk, and duck hawk destroy the insect-eating and the weed seed-eating birds and for that reason may be classed as harmful. The first two also prey upon poultry. The crow is sometimes reckoned as being harmful on account of its pulling up and eating corn after it has been planted; but crows destroy so many mice, worms, and grasshoppers that they more than make good any loss that they inflict on the farmer. The English sparrows are also very injurious on account of their having adopted a vegetable diet in this country.

Beneficial Birds. — Among the birds that are helpful to the farmer are the swallows, woodpeckers, cuckoos, wrens, blackbirds, bluebirds, redbirds, the Baltimore oriole, the mocking bird, and the partridge. The swallows prey upon ants, flies, beetles, and other insects. Cuckoos and wrens eat grasshoppers, caterpillars, bugs, and flies. The bluebird feeds on weed seed in the winter and on grasshoppers and caterpillars in the summer. Woodpeckers eat a great many wood-boring larvæ or worms, and also many ants and other kind of insects that burrow into the trunks of trees. The majority of birds do us a great deal of good by devouring weed seed in the winter time and by devouring many injurious insects in the warm season of the year. Teachers should set aside a part of Arbor Day each year as Bird Day, and have suitable exercises on this occasion calling attention to the value of birds and the importance of protecting them. Organize a local Audubon Society and start a crusade against the merciless and useless slaughter of birds. Literature suitable for this purpose may be

obtained from the State Superintendent of Public Instruction and from the National Audubon Society.

Common Animals.—As in the case of insects we find that some of our common animals are harmful, some are beneficial, while others are harmful or beneficial according to circumstances. All animals that live on a vegetable diet may be regarded to a certain extent as enemies of plants. In the whole list there is no greater enemy of plant life than man himself. Millions of trees are cut down every year to supply his demands for lumber and for the wood pulp needed in the manufacture of paper. Hodge in his book on *Nature Study* says: "It has been estimated that we have five hundred million acres in growing forests, and that thirty-five cubic feet of wood are annually produced per acre. Annual consumption of wood, according to Professor Farrow, is probably double the amount produced. Inferences from these facts are obvious." Unless this waste is checked, it will be only a short time until there will be practically no forests of any note in this country.

But while in this particular instance man seems to be an enemy of plant life, it is also equally true that in many other instances certain plants would not be able to live and thrive except for the protecting influence of man. Many trees, shrubs, and garden plants could hardly exist without the constant attention and care of man.

Harmful Animals.—In the list of harmful animals we may class in a general way, rabbits, rats, mice, gophers, goats, etc.

Rabbits.—Our common rabbits are very widely distributed and are often very destructive on account of their vegetarian diet. The cottontails, or small species of rabbits, do a great deal of damage by gnawing the bark of fruit trees and devouring the young plants in our gardens and truck patches. West of the Mississippi there is a larger species, known as the jack rabbit, which is quite famous on account of its remarkable speed. It is also quite destructive, and is one of the worst pests known on the farm. Fruit trees may be protected to some extent against rabbits by placing common screen wire or gauze around the trunks of the trees at the bottom. Whitewashes containing tar, carbolic acid, and poison have also been recommended, but are regarded by many

as being of doubtful efficacy. Perhaps the most effectual remedy would be a campaign of extermination undertaken by the State or National government.

Rats and Mice. — The common house rats and mice do a great deal of damage by their ravages on the farmer's stock of seed corn and other cereals. They usually eat only the heart or kernel of each grain of corn, so that it will not germinate or sprout when planted. The field mice do a great deal of damage by destroying the corn after it is planted. To guard against their ravages some farmers have resorted to the plan of soaking the seed corn before planting in water containing poison, but this is hardly practicable in large fields. The common house rats and mice may be held in check by catching them in traps, by poisoning their food, or by keeping around the house cats, rat terriers, dogs, or ferrets.

Gophers. — These are small animals that do a great deal of damage by burrowing in the ground and by attacking some of our garden plants. Many lawns are frequently ruined by gophers cutting the roots of the grass and causing the sod to die.

Prairie Dogs. — In many parts of the West there are small burrowing animals that look very much like our common squirrels. They live in colonies or prairie dog towns and do a great deal of damage on account of the many underground passages they construct. Farmers sometimes try to suffocate them with the fumes of carbon bisulphide or try to catch them in traps.

Moles. — These are small animals about the size of a common house rat, which burrow in the ground and excavate elaborate tunnels with their shovel-like feet. They make their tunnels so near the surface that they undermine the roots of grass and small plants. Of course late in the spring with the approach of the dry season this is likely to cause the death of the plants, and steps must be taken to prevent the intrusion of moles among our garden plants at that time. Moles devour the insects that happen to cross their path, and it is possible that the good they accomplish in this way will counterbalance the injury they do the plant when they tunnel through its roots.

They may be caught in mole traps or snares or killed by poisoning food and placing it in the ground where they are burrowing. Many gardeners also advocate planting castor beans or mole

beans in the garden, which, they claim, will prevent the intrusion of moles.

Goats.—Of all our domestic animals the goat seems the most destructive on account of its gnawing propensities in addition to its insatiable appetite. Goats usually strip off all the foliage on young fruit trees that is within their reach and then finish their work of destruction by gnawing off the bark around the trunk of the tree. The only safe plan is to keep them out of the orchard and the yard or flower garden.

Beneficial Animals.—There are some animals that are very beneficial to plants on account of their living upon insects injurious to plants.

The Toad.—A great many people look upon the common toad as an ugly repulsive animal that is of no particular use to any one, but this is a wrong idea which we should lose no time in correcting.

Toads devour thousands of insects and in this way do us a great benefit. Flies, worms, and bugs are the natural food of toads; and when you reflect upon this, you surely will feel more kindly disposed towards them. It is estimated that insects destroy crops every



Toad.

year worth at least five hundred million dollars. During the day the toad usually hides away in some safe nook or shelter, but as night approaches he creeps forth in search of his food. In cities and towns we frequently see large numbers of toads sitting under the arc lamps in the streets to catch the insects which then flutter around these lights and fall to the ground. If you were to count the number of insects devoured by a single toad in the course of an evening, you would be surprised at the capacity of his stomach and would learn to prize him more highly as a friend of plants and indirectly as a benefactor of the human family. If we were to domesticate toads and keep them in our gardens, we should have much less trouble with insects and should have much better success

with our plants. By surrounding the garden with finely woven poultry wire fencing toads may be confined within the premises and we can satisfy ourselves as to the advantage of their presence. If this is not done, the toads will make their escape.

The Horned Toad.—The so-called horned toad is really a lizard found in the dry prairies and plains of the United States and Mexico. In Arizona, California, Texas, Kansas, and Oklahoma they are very abundant and may be captured without much difficulty. They resemble the common toads, but are much smaller, and their bodies are covered with scales and spines of a brownish, dusky tint. On each side of the animal's head is a short heavy spine or horn, and on account of this fact it is known as the horned toad. They feed on flies, ants, and other small insects.

Frogs.—Our common frogs are another class of animals that do us good service in devouring insects. They look very much like the common toad, but spend the most of their time in water instead of living on land.

Other Beneficial Animals.—It is frequently found advisable to turn hogs into our orchards in order that they may capture and devour the grubs or larvæ of objectionable insects that may be present on the ground. It will be found advisable to adopt some means of preventing the hogs from rooting up the ground and doing too much damage in this way. This is usually accomplished by clamping an iron ring or crescent in each hog's nose. Besides eating up the grubs, the hogs will also eat up any diseased or decayed fruit that may fall from the trees.

Sheep are sometimes turned into fields to subdue weed pests, and they do the work very satisfactorily. Goats are frequently used for the same purpose if there are no fruit trees around.

EXERCISES

1. Ascertain the cost of a formaldehyde solution for a bushel of seed oats, and then calculate the cost for the seed required to sow a field of forty acres.
2. Estimate the amount of Bordeaux mixture necessary to spray an acre of potatoes and calculate cost for a field of twenty acres.
3. How many bushels of potatoes at seventy-five cents per bushel will it take to pay for the Bordeaux mixture used in the above problem?
4. Estimate the labor required and calculate the number of bushels of potatoes that will be required to pay for the labor.

QUESTIONS

1. Discuss the meaning of the term *insects*.
2. Discuss the general classes of insects.
3. What sprays are recommended for biting insects?
4. Describe in a general way the sucking insects.
5. What kind of spray should be used against these insects?
6. Name some simple remedy that may be used against soft-bodied insects.
7. Discuss predaceous insects.
8. Name some of the common insect enemies.
9. Discuss the plum curculio.
10. Describe the potato beetle and suggest remedy.
11. Discuss (a) the cankerworm, (b) the army worm.
12. Describe (a) the tent caterpillar, (b) the tobacco worm.
13. Discuss the cotton-boll weevil and suggest means of fighting it.
14. Discuss (a) cutworms, (b) the codling moth.
15. Describe (a) the Hessian fly, (b) the San Jose scale.
16. Discuss the general idea that birds are injurious to farmers.
17. Discuss harmful birds.
18. What can you say of harmful animals?
19. Discuss (a) rabbits, (b) rats and mice, (c) gophers.
20. What can you say of the prairie dogs?
21. Discuss (a) moles, (b) goats.
22. Name some animals that are beneficial to plants.
23. Discuss (a) the toad, (b) horned toad, (c) frogs.
24. Name other animals that may be beneficial.

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XXIX. HORTICULTURE

THE word *horticulture* is of Latin derivation and translated literally means *garden culture* or the cultivation of garden products. It is used in a much broader sense, however, and it includes the cultivation and growing of vegetables, fruits, flowers, and ornamental plants.

Horticulture may be subdivided as follows:

1. Olericulture or vegetable gardening.
2. Pomology or fruit growing.
3. Floriculture or flower gardening.
4. Landscape gardening, or the designing of landscape effects in the arrangement of ornamental plants.

Vegetable Gardening may again be subdivided into *market gardening* and *home gardening*. *Market gardening*, as the name implies, has for its object the raising and marketing of vegetable products for profit; while *home gardening* has for its object simply the raising of vegetables for home use. Market gardening, or truck farming as it is sometimes called, may be carried on very profitably in many parts of the United States where the soil, climate, markets, and transportation facilities are favorable. The best truck patches or market gardens are found in the Atlantic and Pacific belts, but truck farming is also successfully carried on in many of the Northern, Central, and Southern States. From five to ten acres is the average size of these farms; and the truck growers who own them usually realize handsomely on their investments, especially when the farms are within easy reach of the market in some large city. In Colorado, Arizona, New Mexico, Nevada, California, Idaho, Montana, Utah, and Washington truck farming is carried on very successfully in the irrigated districts, and good markets are found in the adjacent mining regions where vegetables cannot be successfully grown.

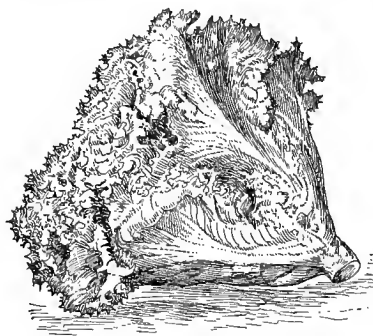
Marketing Crops. — It is now possible to transport perishable products in a very short time from one part of the country to

another, so that the factor of distance is not so important as formerly. When the market is oversupplied in one part of the country with a certain article, the railroad enables us to ship it to some other place where a demand for the article exists. Thus in the spring the excess of early vegetables and fruits in the South may be shipped North, where a ready and profitable market may be found for them. Later in the season, when the dry hot weather in the South has made gardening less favorable, the surplus garden products and fruits of the North can be shipped South to advantage. Sometimes there is a general failure of all crops throughout the year, and famine would result but for the facilities in rapid transportation afforded us by our railroad and steamship lines, which make it possible for us to secure these things from other more fortunate countries on short notice. The modern refrigerator or cold storage cars make it possible to ship perishable fruits and meats to all parts of our country without danger of loss or decay, regardless of distance. Cold storage warehouses make it possible to preserve perishable products until they can be used. Beef, pork, eggs, butter, fruit, and vegetables are collected in our market centers and are placed in cold storage until the demand for these articles is such that they can be sold at a profit.

Improved methods in canning, in preserving, and in drying have made it possible to save perishable products so that they may be offered for sale at a time when the market is not glutted.

The Hotbed. — Early crops are made possible by the use of the greenhouse, hotbeds, and cold frames. The greenhouse is somewhat difficult of construction and management and is seldom found practicable on small truck farms. The hotbed is easily made, and there is no reason why every farmer should not have one. The box or frame may be of any convenient size and should be about twelve inches high on the north side and about eight inches on the south side. Before putting the frame in position dig a pit at least two feet deep and one foot larger each way than the frame to be used. When this is done the pit should be filled with fresh horse manure containing a liberal amount of straw bedding. This manure should be stirred several times with a fork and kept moist by watering if necessary until the whole mass is heating moderately and uniformly, and as soon as this is

accomplished tramp the manure down firmly. Then light, rich, friable soil should be evenly distributed over the surface and carefully leveled. Leave the hotbed partially open for several days until



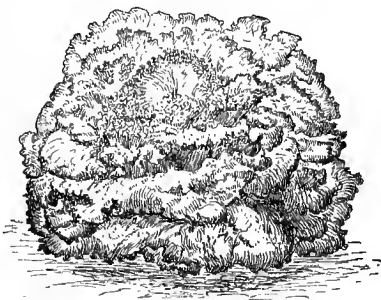
Loose-leaved lettuce.

the heat drops to 65° at night and remains comparatively constant; then the hotbed is ready for sowing. In severe weather manure should be kept piled on the outside of the frame level with each side, and when examining the plants we should be careful not to expose them to a cold draft of air which would check their growth. The whole frame should be covered with glazed sashes, so arranged that

they can be easily replaced or moved as may be desired. Under a warm bright sun the hotbed easily overheats, and we must open the sash and provide proper ventilation. The cold frame differs from the hotbed in having no manure or other heating material. The cold frame is used to harden plants and at the same time protect them and keep them growing.

Garden Vegetables.—*Lettuce* is a small plant much used in making salads. The principal kinds are the heading varieties and the curled or loose-leaved varieties. The seed should be planted in beds or rows early in the spring and should be covered very lightly and sparingly with warm rich soil.

Spinach is a common pot herb. It is sowed in drills twelve to eighteen inches apart, and the plants are thinned out



Head lettuce.

after the leaves become about an inch in width. The favorite varieties are the Savoy leaved, the New Zealand, and the Victoria.

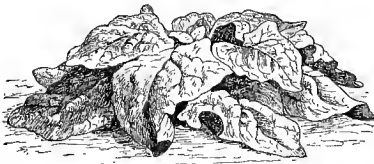
The onion is one of our most useful garden vegetables. It not

only contains considerable nutriment, but has valuable medicinal properties. It is said to be a valuable article of diet for those who live sedentary lives. It will grow in almost any rich loam which has only a slight mixture of clay. Onions may be grown from either seeds or sets. In gardens the sets are usually placed in beds and in short rows fifteen to eighteen inches apart, but in truck patches the sets are placed in long rows so that the onions may be plowed with a cultivator. Onion growing is usually found profitable, and the yield usually varies from three to five hundred bushels per acre under favorable conditions on rich soil. Some of the best varieties are the round white silverskin, mammoth, silver king, Michigan yellow globe, the early red and the large red Wethersfield.



Savoy leaved spinach.

Celery is one of our highly prized vegetables and is not very difficult to grow when handled properly. For home use it may be grown by what is called the new process. This consists in making the celery bed as rich as possible and setting the plants in it six to eight inches apart or close enough so that the plants will blanch each other. The plants are grown from seed sown in shallow boxes in which the soil is kept very



Victoria spinach.

moist all the time until the seed germinate. In sowing care must be taken not to cover the seed too deep. The seed should be sown in the spring and the plants set out in rows early in the summer. In setting the plants make broad trenches about six inches deep and four to six feet apart and set the plants at intervals of every six or seven inches. When the plant is nearly full grown, press the leaves closely together and pull the earth around the plant to one third of its height, taking care that

none of the soil falls between the leaves or stems. After a few days draw a little more soil around the plants and repeat the process every few days until only the tops of the plants can be seen.

A great deal of celery is raised in Michigan, Ohio, and New York, and also in Florida, Arizona, California, and New Mexico. Some of our best varieties come from Kalamazoo, Michigan, and Roswell, New Mexico.

The Cabbage grows well on rich land in almost any part of the United States. The seed is sown in hotbeds or in small boxes filled with soil and kept in a warm place until the weather is favorable for transplanting. Then the plants are set out twenty to thirty-six inches apart in three-foot rows and are kept well cultivated. The young plants are rather tender and demand constant care and attention in the beginning. One of the worst enemies of the cabbage plant is the cabbage worm, and the successful gardener must be ever on the watch for its appearance. In the fall, before freezing begins, gardeners usually gather their cabbage, place them in a cool, dry place, heads down, and cover them several inches deep with clean dry soil. This protects the heads from freezing, and makes it possible to carry the cabbage through the winter without damage. In southern California, southern Texas, and Florida the climate is so mild that this is not necessary, and cabbage is grown and cultivated all through the winter months. Here the cutting and shipping season extends from March until June.

It is said that the first cabbage known to the English were brought to England by the Romans, and from that place the plants were brought by our Pilgrim forefathers to the United States.

Asparagus is very hardy and is a very popular vegetable. Before sowing the seed they should be soaked in water not quite scalding hot for several minutes, or until the water becomes cool. Then pour this off, and repeat the hot water treatment two or three times. The seed then should be sown in drills one foot apart and should be covered not more than two inches deep with nice rich soil. When the plants come up, they should be thinned out so that they will be at least an inch apart. In the fall the plants should be set out in the asparagus bed, which

should be broken deeply and well manured beforehand. Set the plants about four inches deep and about one or two feet apart in three- or four-foot rows. Then cover the plants with rich soil and a layer of stable manure. Early the next spring add another dressing of manure and wood ashes, and sprinkle the bed with a little salt. Keep the bed well cultivated and pull out all weeds and grass. The plants should not be cut until they have had three years' growth. When prepared for market use, the stalks are tied up in bunches of ten or twelve.

Asparagus is one of our oldest vegetables and it has a very interesting history. It is said that it was first used in Rome and was carried by the Roman soldiers to the Gauls and Britons. When our English ancestors came to New England, they brought this plant with them; and now there is scarcely a part of our country where it is not grown.

Rhubarb, Pie plant, succeeds best in deep rich soil. The plants should be set not less than three or four feet apart when transplanted. The stalks should not be cut until the second year, and the plant should not be allowed to exhaust itself by going to seed.

The Tomato is now to be found in nearly every garden in the land, but formerly it was cultivated only as an ornamental plant. It was called the love apple and was thought to be poisonous. Packers estimate that at least three hundred thousand acres are required to meet the demands of the canning industry alone. If we add to this the acreage required for home consumption and other purposes, the total acreage will be not far from half a million.

All the numerous varieties of tomatoes now grown are the offspring of a single plant that was found in the Andean region of South America. California, Maryland, New Jersey, Indiana, Florida, and Texas are the leading tomato-growing States.

The seed should be sown in the same way as for cabbage, and the young plants, after hardening, should be transplanted and placed in rows not less than three feet apart. When possible the plants should be supported by stakes or a trellis.

The Eggplant, like the potato and the tomato, is a member of the nightshade family, but is not so well known as they are. The

seed should be sown in shallow boxes and kept in a warm place until the young plants have formed at least two rough leaves before attempting to transplant them. These plants are very tender and should not be set out until all danger from frost is past. Should the weather set in very warm, it will be advisable to shade the young plants from the sun. It will also be necessary to protect the plant against the potato bugs, which seem especially fond of preying upon its leaves. When the plant matures it bears a large purple-skinned fruit a little larger than the Ben Davis apple.

The cucumber can be grown very easily by any one, and it is a very popular article of diet in the summer time and fall. The cucumber is a native of southern Asia, and was brought to America, at an early date, by English colonists. In planting sow about a dozen seed in a place, and arrange the plants in four-foot rows. After the plants come up, thin them down to four or five in each group. The yield will be greatly improved if the soil has been previously enriched with a liberal dressing of well-rotted manure. After the plants come up, give frequent, but shallow, cultivation until the runners from the plants cover the ground. Remove the cucumbers as fast as they become large enough to use, and always clip them from the vine with a knife instead of pulling them off by hand. If the growth of the vine is too rank, pinch off the terminal and some of the lateral buds. Slacked lime, tobacco dust, and wood ashes will be found useful in keeping off beetles and other insects which attack the plants.

The watermelon came originally from tropical Africa, and has been cultivated from early times. It is now grown extensively in many parts of the world, and especially in the United States. The seed should be planted in rich ground, well manured, and in hills about eight feet apart. The manure should be well rotted and the seed should not be planted over an inch deep in the soil. As in the case of cucumbers, it will be found advisable not to plant the seed until the ground has become thoroughly warm and all danger from frost has passed. The best melons are raised in Georgia and Oklahoma.

The muskmelon is a native of Asia, but is now extensively cultivated in many parts of the United States. New Jersey, Mich-

igan, Colorado, Arkansas, Texas, Oklahoma, Arizona, California, and New Mexico now grow large quantities of both muskmelons and watermelons. There are two well-defined varieties of muskmelons, one known as the cantaloupe and the other as the nutmeg melon. The former has hard rinds, and the latter is a netted type with softer rinds. The best nutmeg melons are the Rocky Ford melon grown in Colorado, and the Netted Gem melon grown in southwestern Michigan and elsewhere.

Muskmelons should be planted and grown in the same way as watermelons. Both require light, rich, sandy soil to make their best growth.

Pumpkins are cultivated in the same way as melons but on a much larger scale. They are usually planted in fields between the hills of corn and will grow and do well on a variety of soils. They mature in the fall and assume a rich golden hue.

The pumpkin is said to be of tropical American origin and was cultivated by the early Indians in this country in their fields of corn. A great deal of pumpkin is now canned, and it forms a very profitable industry. In some parts of the United States pumpkins are fed to stock and are found very satisfactory for this purpose.

Squash.— This is a very important and a very nutritious garden vegetable which can be grown in nearly every part of our country. The squash requires the same kind of culture and attention as cucumbers and melons.

Peas have been known and cultivated in Europe and Asia from the earliest times. The best-known varieties are the garden peas used as a vegetable and the field peas grown as forage for stock and as a soil renovator. Large quantities of garden peas are canned every year.

Beans.— Our common garden bean is a native of South America which was carried to Europe and was then brought to America. The native European bean does not do well in the United States. Some of the leading varieties of our beans are the black wax, the golden wax, the crystal white wax, the dwarf bush, etc. All these varieties are sensitive to cold and must not be planted until all danger from frost is past. Another popular variety of bean is the Lima or butter bean, which is also a native of South America.

Both dwarf and pole varieties are generally grown, with a preference for thick-seeded dwarf varieties in some localities. It is a favorite vegetable for canning purposes.



Okra.

Okra. — This plant is also known as *gumbo*, and is cultivated for its pods, which are used frequently in making soups, especially in the South. It is also stewed and served like asparagus. The seed should be sown in hills about three feet apart and from four to six seed should be planted in a hill. After the plants come up, it will be well to thin them out, and to leave about two plants in a hill. Okra may be grown almost anywhere, but it is raised chiefly in the Southern States.

Pepper. — Like okra, the pepper plant is cultivated chiefly for its pods, which are used for seasoning meats and foods of various kinds.

In Mexico and South America many of the hot varieties are eaten raw. In this country, they are served either green or ripe, and may be eaten raw with vinegar and salt, or may be filled with special dressings and then stewed before serving. The culture for pepper plants is practically the same as for eggplants. The yield and quality of fruit will be greatly improved if the ground is enriched with hen manure.

Other Vegetables, such as radish, turnip, carrot, beet, salsify, are readily grown in nearly every part of the United States. They have already been described under the head of root crops.

EXERCISES

Secure catalogues from various seed houses which give the price of seed in bulk, and estimate the amount of seed required for seeding an acre of ground and solve the following problems. Also ascertain the market prices of vegetables from the market quotations in some newspaper.

1. Which is the most profitable crop, lettuce or spinach? Why?
2. Ascertain the cost of onion sets, the labor required for planting and

cultivating, the yield per acre, the market price of onions, and estimate the profits that may be realized on five acres of onions.

3. Which is the most profitable, five acres of onions or five acres of cabbage? Prove your statement.

4. Estimate the cost of growing ten acres of tomatoes and the profits that may be expected.

5. Which will be the most profitable, five acres of muskmelons or five acres of watermelons? Why?

6. Estimate the profit in five acres of beans.

7. Which is the best investment, ten acres of turnips or ten acres of beets? Why?

QUESTIONS

1. What does the word *horticulture* mean?
2. Give the divisions of horticulture.
3. What is vegetable gardening?
4. Discuss (a) home gardening, (b) market gardening.
5. Name the causes that make truck farming profitable.
6. Discuss the hotbed and its advantages.
7. Describe the cold frame and its uses.
8. Discuss the cultivation of (a) lettuce, (b) spinach.
9. How should onions be planted and what varieties are grown in your locality?
10. Discuss celery and its cultivation.
11. Discuss the growing and marketing of cabbage.
12. Give a brief mention of the early history of cabbage.
13. Discuss the history and cultivation of asparagus.
14. Tell what you can of tomato culture.
15. Discuss (a) the eggplant, (b) cucumbers.
16. Discuss the cultivation of melons.
17. What can you say of the growing of muskmelons?
18. Discuss (a) pumpkins, (b) squash.
19. Discuss the cultivation of (a) peas, (b) beans.
20. Give a brief mention of (a) okra, (b) pepper.

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XXX. SPECIAL HERB AND LEAF CROPS

No garden is complete without a few herbs of some kind. For convenience they may be divided into two classes: (1) aromatic herbs, and (2) medicinal herbs. Nearly all varieties may grow almost anywhere, but they thrive best on sandy soil.

Aromatic Herbs are used chiefly for flavoring and seasoning. Some of them also have medicinal properties. In the list of aromatic herbs may be mentioned the following: (1) sweet basil, a plant with a clovelike odor, used for seasoning soups and sauces; (2) caraway, used for seasoning soups and flavoring cakes; (3) coriander, whose seed afford a very desirable flavor for some articles; (4) dill, an annual whose seed is highly esteemed in flavoring pickles; (5) sweet fennel, a hardy perennial whose leaves are used in flavoring soups, sauces, garnishes, and salads; (6) sage, whose leaves when dried are used for seasoning sausage, etc.; (7) thyme, used for seasoning soups, dressings, and sauces.

Medicinal Herbs. — These are herbs which have some special medicinal quality for which they are chiefly valued. In the list of medicinal plants may be mentioned: (1) anise, an annual herb whose seed has an agreeable smell and taste; (2) balm, a perennial herb whose leaves have a fragrant odor, used in making balm teas for use in fevers; (3) catnip or catmint, a hardy perennial, highly esteemed as a nervine for infants; (4) horehound, a perennial herb with strong aromatic smell and a bitter pungent taste and highly esteemed as a tonic for coughs and colds; (5) hyssop, a hardy perennial, valued as a stimulant and expectorant in treating asthma and chronic catarrh; (6) wormwood, used as a tonic and vermifuge and as a dressing for bruises.

Leaf Crops. — Under the head of leaf crops, there are many plants that we might discuss, but at this time we wish to call attention only to tea and tobacco.

The tea plant is a bush from three to five feet in height, and its leaves resemble those of a rosebush or a willow tree. It is a

native of subtropical Asia, but grows wild in the Himalaya Mountains and often reaches a height of fifteen to twenty feet in its wild state.

Tea has been cultivated in China and Japan for hundreds of years, and it is a very important industry in both countries. The plant is very hardy, and is now being successfully grown in some of the Southern States. The leaves are not considered fit for use until the plants are three years old. The young leaves and the



Picking tea, India.

freshly opening buds make the best tea. The first picking is generally in April, the second in May, and the third in June, and sometimes a fourth picking may be made later in the season. The average yield for each year is generally not more than a pound.

In making green tea, the fresh leaves, almost as soon as they are gathered, are roasted or steamed for a short time. Then the leaves are placed on a table and rolled by hand and finally taken back and roasted again for about an hour. They are stirred constantly while the roasting goes on, and at the end of the hour the tea takes on a decided green color. The leaves are then sorted and prepared for shipment. The color of tea cannot

always be relied upon to indicate the quality of the tea, since, in both China and Japan, green teas are sometimes colored with indigo and other materials.

The process for making the black teas is somewhat different from that required in preparing the green teas. The leaves are exposed to the action of the sunlight until they wilt and begin to ferment. This fermentation is prolonged until a certain odor is given off, which is easily recognized by expert workmen. The tea is then placed on a table and carefully rolled for twenty-five



Weighing tea, Japan.

or thirty minutes, after which it is packed tightly in baskets, and left to go through a second stage of fermentation. Finally it is put through another rolling process, preparatory to roasting it on iron gauze sieves over a slow, even fire.

The tobacco plant is a native of America, and is one of the crops that was grown by the Indians at the time that our earliest settlers came to this country. Sir Francis Drake is credited with having carried the first tobacco from Virginia to England, and Sir Walter Raleigh is said to have been the first person to introduce its use at the court of Queen Elizabeth. Since then the use of tobacco has spread over practically the entire world.

The leaves are used for making cigars, cigarettes, and ground tobacco for smoking, and for making plug tobacco, which is used for chewing. In pioneer days, tobacco often took the place of money, and we are told that many of the young colonists bought their wives by paying for their passage across the Atlantic with one hundred and twenty-five to one hundred and fifty pounds of tobacco.

Our chief tobacco-producing States are Kentucky, North Carolina, Ohio, Tennessee, and Virginia. But tobacco will grow in North America almost everywhere from the equator to Canada.



Tobacco field, Kentucky.

The plants are first grown in a seed bed, and then transplanted, if possible, when the weather is moist and cloudy. The plants should be set out about three feet apart, in four-foot rows. They should have frequent and shallow cultivation. During the growing season, the plants must be topped, and all suckers cut off, in order to insure evenness of size and quality in the leaves.

The finest-flavored tobacco is grown in Cuba, Porto Rico, Sumatra, Java, and the Philippine Islands. The Havana cigar and the Manila cigar are known the world over. Our tobacco

crop is often worth seventy million dollars or more, and each year the acreage grows larger.

EXERCISES

1. Consult some good physiology as to the injurious and stimulating effect of tea.
2. Discuss the injurious effect of tobacco on the human system.
3. Discuss the profits in raising herbs.
4. If possible, visit a cigar factory and ascertain cost of making cigars, amount of internal revenue tax on cigars, etc., and estimate profit on a box of cigars.
5. Calculate number of tobacco plants required for five acres of ground when they are planted every two feet in rows three feet apart.
6. Estimate the amount of tobacco used last year and its cost.
7. Estimate the amount of money spent for tea.

QUESTIONS

1. Name the two general classes of herbs.
2. Discuss the aromatic herbs.
3. Describe the medicinal herbs.
4. Discuss the tea plant.
5. Where is tea cultivated?
6. How is green tea prepared?
7. How is black tea prepared?
8. Give the history of the tobacco plant.
9. Name some of the manufactured products of tobacco.
10. Name the tobacco-growing States.

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XXXI. SMALL FRUIT CROPS

Berries. — The berries include the raspberry, blackberry, strawberry, cranberry, and dewberry. To this list might be added the coffee berry, from which we obtain the bean or seed known as the coffee of commerce, and the cacao fruit, from the seeds or beans of which are obtained the cocoa and chocolate of commerce. The last two plants named have not yet been successfully grown in the United States, but the products of these plants are in such general use in this country that some mention should be made of them.

The Raspberry. — As a rule, raspberries thrive the best in a moist and fertile loam. They are grown more extensively in the northeast part of the United States than elsewhere. There are two principal varieties: the red raspberry, which is soft and unsuitable for shipping, and the black raspberry, which has a tougher texture and can be shipped without difficulty. Waste space along the fence or ravines may be utilized for the raspberry patch. In order to secure good results remove all the dead stalks each fall, and keep the ground well cultivated and well manured.

The blackberry, like the raspberry, is a native American plant, and in its wild state it has been known and prized for a long time.

Under cultivation and careful selection this plant has steadily improved and is now one of our most important crops. Many new and valuable varieties of the cultivated species have been originated, and are now extensively grown in nearly every part of the United States. Its fruit is utilized in commerce in making wine, cordial, jelly, jam, and preserves.



The Lucretia Dewberry.

The Loganberry. — This is a hybrid berry of considerable value for the home garden in some localities. It succeeds best in California where it originated, but has been grown in the New England and Middle States with careful winter protection. The fruit is a rich dark red color when ripe, an inch or more in length, and has the flavor of a blackberry.

The Dewberry. — The stems of the dewberry plant show a tendency towards trailing, and are not so erect as the blackberry stems. Its fruit is of fewer grains and ripens earlier than the blackberry. The blackberry has from three to five ovate leaflets, while the dewberry has from three to seven small doubly-toothed leaflets. The dewberry is especially adapted to rocky and sandy soil, but under cultivation it has adapted itself to a variety of soils and climates. Its commercial uses are practically the same as for the blackberry.

The Strawberry. — The common garden strawberry is the offspring of a wild species of the plant, native along the Pacific coast of America, and which was first cultivated in Chile nearly two hundred years ago. It has been under cultivation in this country for the past sixty years, and is one of our most important industries. In many parts of the United States the strawberry grows in a wild state, but it does not lend itself to much improvement under cultivation, as does the South American variety. The cultivated varieties of the common garden strawberry are now grown from Florida to Alaska, and on account of its wide range of growth we are able to have strawberries on the market a large part of the year. The early crop in the spring is grown in Florida, South Texas, and other Southern States, and this in turn is followed by the crop grown in Arkansas, Missouri, Oklahoma, and other States near the same latitude. Later the market is supplied from the crop grown in the Northern States, so that the season for strawberries is made much longer than it otherwise would be.

The strawberry plants propagate by runners, which are set out either in the spring or in the summer, in beds or rows, in rich sandy soil. Through the winter the young plants should be protected with a moderate covering of straw. Wood ashes and fertilizers of

like nature improve the yield and quality of the fruit. Generally, after the second crop has been gathered, it is best to plow up the plants and set out a new bed. For market purposes, the strawberries are packed in small baskets and placed in crates for shipment.

The cranberry is a native of both Europe and America. In this country, cranberries grow in boggy lands, from Maine southward to New Jersey, and also in the swamp lands of Michigan, Minnesota, and Wisconsin. It is estimated that 90 per cent of our cranberry crop is grown in Wisconsin, Massachusetts, and New Jersey. The small cranberries found in the market are generally the product of vines growing in a wild state, while the large berries come from the cultivated plants.

The plants may be grown from seed, but usually they are grown from cuttings, set out a little over a foot apart in rows. In a little while the vines spread over the whole space. The plant has small evergreen leaves, somewhat whitish underneath, and early in the summer it bears flowers with a pale rose corolla, deeply parted. In the fall the berries gradually assume a pale red hue and mature. They are then gathered by hand or machinery and packed in barrels or crates and shipped.

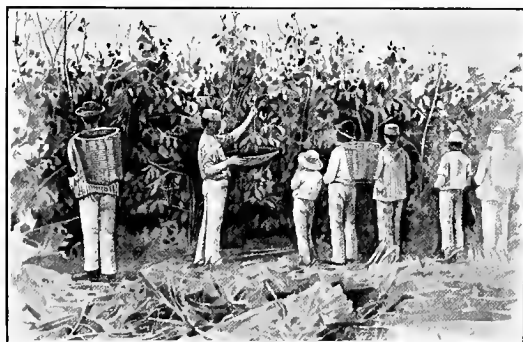
The cranberry farm, like the rice farm, gives the best results when it is situated so that it may be flooded at certain times of the year, as the needs of the plant may demand.

Huckleberries. — Huckleberries are not cultivated for commercial purposes, but are picked from plants growing in the wild state. In Maine it is estimated that there are no less than one hundred and fifty thousand acres which produce the blue-fruited variety of huckleberries. These are frequently termed "blueberries," on account of their rich, blue color, while the term "huckleberries" is usually applied only to the black-fruited varieties.

Mulberries differ largely from the classes of berries just described in that they grow on trees. The trees grow from fifteen to fifty feet in height according to the variety, and bear heart-shaped or ovate leaves. The white mulberry is found in the Eastern States, and the Russian mulberry is a form of it. The black mulberry is found growing in protected places in New Eng-

land and New York. The red mulberry is generally distributed from western New England to Nebraska, and southward to the Gulf. The fruit is deep red at first, but becomes somewhat black when fully ripe. In southern latitudes the fruit becomes fairly large in size, has an agreeable taste, and is highly esteemed as a fruit.

The Coffee Berry. — The coffee tree is said to have originated in Abyssinia and to have received its name from the province of Kaffa, where it may be still found growing in a wild state. Later it



Picking coffee.

was carried over to Mocha, in Arabia, and to Java, and in this way were derived the two celebrated varieties of coffee known to-day under those names. Since then it has been taken into practically every tropical country of the world. It can-

not be grown farther than 30° north or south of the equator with any degree of success. The chief coffee regions of the western world are in Brazil, Central America, Mexico, and the West Indies. It is also grown in Cuba, Porto Rico, Hawaii, the Philippine Islands, Australia, Java, Sumatra, Ceylon, Hayti, San Domingo, Colombia, Venezuela, Ecuador, Peru, and Chile.

The coffee plant is an evergreen with shiny leaves, which generally grows from twelve to twenty feet in height in its natural state, but when under cultivation it is seldom allowed to attain more than half that height.

The plant bears fragrant white blossoms, some time in December in regions south of the equator, and in a little while the blossoms drop off and the berries form. Usually in April or May the early berries begin to turn red, and the picking season begins. Each berry is about the size and shape of the ordinary cranberry, and in each berry are found two seeds or beans. After picking, the

coffee berries are taken to the factory to be treated, so that all the pulp may be removed from the coffee bean, which is the coffee of commerce.

The berries are run through machines which slightly mash the pulp without injuring the seeds, and then the whole mass is carried over a large copper cylindrical sieve, containing perforations just large enough for the coffee beans to pass through without difficulty. The beans, as they fall through the cylinder, are washed away by a stream of water, which carries them off into large receiving vessels. Then, while in the vats, the beans are scoured and cleaned by machinery, so that not a vestige of the pulp remains. Then they are spread out in large fields, paved with cement, and are left exposed to the sun for several weeks. During this time the beans must be stirred with rakes frequently during the daytime, and at night they must be carefully covered so that they will not become damp from the moisture in the air. After being dried thoroughly, the double skins or envelopes, which surround the seed, must be removed, and the beans are passed through a machine which breaks the skins and fans away the chaff. Finally, the beans have to be sorted and graded and put into sacks ready for shipment. Each sack holds about one hundred and thirty-two pounds. After being shipped to this country in the raw state, coffee is prepared for use by roasting the olive-green beans until they take on a rich brown color, and then they are taken out and ground in a coffee mill as needed. The amount of coffee consumed annually is very large. The annual crop of the world is not far from fifteen hundred million pounds, and more than four fifths of this is grown on the Western Continent.

The cacao tree and its fruit furnish us with the ordinary chocolate and cocoa of commerce. This tree, like the coffee tree, will grow to a height of fifteen to twenty feet if not pruned from time to time. It is an evergreen, with large glossy leaves. It has pinkish white blossoms, and its fruit or pod is about the size and shape of a very large pear. This contains from twenty to forty cacao beans or seeds, each about the size of an almond. Each bean contains a dark brown kernel, rich in oil, and it is from this kernel that our commercial chocolate is manufactured. The cacao trees begin bearing in their fourth or fifth year, and reach their

maximum yield in their eighth year, when each tree will yield about eight thousand seeds.

The pods containing the seed grow not only on the branches of the tree, but also along the main trunk. In gathering the seed, the natives fasten sharp knives to long poles, which they use to cut off the pods that are out of reach.

After the beans are removed from the pods and cleansed thoroughly, they are roasted in large revolving cylinders, and finally crushed in order that the kernels may be removed. The kernels are afterwards put into machines and ground up and reduced to the consistency of a fine smooth paste which is run off into molds, where it hardens. If sweet chocolate is desired, a little sugar is added to the paste before it is passed into the molds. From the cacao nibs, cocoa shells, or broken pieces of the beans is prepared an essence of cocoa by pouring upon them boiling hot water. The demand for cocoa and its manufactured products is so great that several hundred million pounds of it are consumed every year. It is used not only as a drink, but also in the manufacture of flavoring sirups, candies, cakes, and puddings.

The history of the cacao bean is interesting; it is claimed that the ancient Aztec Indians knew the value of this plant even in their early day. Cortés, the Spanish explorer who conquered Mexico, found the natives using a drink made from the cacao seed, and Pizarro likewise found the Incas using the same drink in Peru. The Spaniards carried the seed back to Spain, and introduced it among their friends there, and since then its use has gradually spread over nearly the whole world.

It is now largely grown in Mexico, Central America, Ecuador, Colombia, Venezuela, Brazil, the West Indies, parts of Africa and Asia, the Philippines, Hawaii, Java, and many of the Pacific Islands.

The Gooseberry. — Gooseberry bushes should be set out four feet apart, and the ground should be kept free from weeds and grass. The gooseberry has been known and grown for hundreds of years in England, it does well in the northern part of the United States, especially in the State of Indiana. The green gooseberries are largely used for making sauce, for making pies, and for canning. The ripe gooseberries are used frequently for making jelly and wine.

The Currant grows well throughout northern Europe, the northern part of the United States, and also in Asia. Currants are largely used in making currant jelly, and it is estimated that no less than ten million quarts of currant jelly are made in the United States every year.

EXERCISES

1. If a crop of thirty bushels of strawberries to the acre is only about proportionate to a corn crop of ten bushels on the same ground, compare the relative values of five acres of each when an acre of strawberries produces one hundred and twenty-five bushels of fruit worth twenty-five cents a quart, and an acre of corn produces forty bushels of grain worth thirty cents a bushel.
2. Estimate the relative cost of production of each of the crops mentioned above and calculate the profits in strawberry culture.
3. Visit some nursery, if possible, and learn something about the culture of blackberries and raspberries, and estimate the comparative values of an acre of each crop.
4. Secure estimates on the amount of coffee used annually in the United States and calculate the expenditure for the same.
5. Study the injurious and stimulating effects of coffee.

QUESTIONS

1. Discuss raspberries and their culture.
2. Describe blackberry culture.
3. What are the distinct characteristics of the loganberry fruit?
4. Describe the dewberry.
5. Discuss the strawberry.
6. Describe the cranberry industry.
7. Discuss (a) huckleberries, (b) mulberries.
8. Describe the coffee berry.
9. Where is coffee grown?
10. Describe the preparation of coffee for the market.
11. Discuss the cacao tree and its fruit.
12. Give the history of the cacao tree.
13. Describe the gooseberry and the currant.

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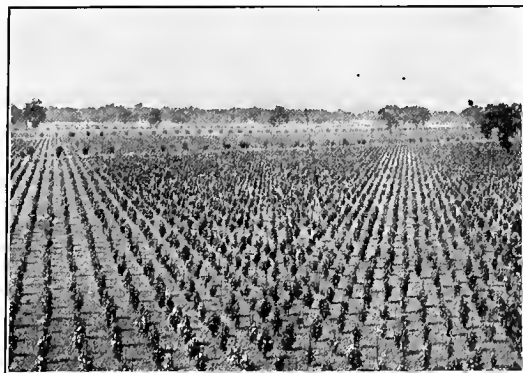
XXXII. SPECIAL VINE CROPS

SOME of the vine crops are not very closely related, but for convenience they are grouped together here. Some of those that we shall discuss now are grapes, hops, black pepper, and vanilla.

Grapes. — Raising grapes is a most important industry. The grape is one of the oldest cultivated plants, and was known to the ancient Greeks and Romans, and also to the Egyptians. The Scuppernong, the Catawba, and the Concord have been developed from varieties that were found growing wild in this country. It is said that the first attempt at growing grapes in this country was made by a Frenchman at Jamestown, Virginia, in 1610; and since then their culture has spread all over the United States. Large quantities of grapes are raised in New York, Ohio, Virginia, Missouri, the Southern States, California, New Mexico, and Arizona. California leads all the States in grape culture, both as to quality as well as to quantity. Some of the varieties

grown there are of European origin, but the white Muscatel, which is so largely grown, was brought to California from Chile.

Grapevines are propagated from cuttings and layers, and grow best in warm fertile soils, with sunny exposure and not



Vineyard, California.

too much moisture. The varieties found in the eastern part of the United States are usually trained to trellises or stakes or to run over arbors, but in California each vine stands alone and generally without any support.

Grapes are raised to be eaten raw, for making grape butter, for wine, and for making raisins. When grown for raisins, the grapes are picked and placed carefully bunch by bunch in a tray about three feet long by two feet wide. Each bunch is cut from the vine with a sharp knife, in order that the vine may not be injured or the fruit bruised in handling it. Twenty-five pounds of ripe grapes will make about five pounds of raisins. When each tray is filled with grapes, it is left exposed to the sun's rays for a week, and then another tray is placed over the half-dried grapes, and they are carefully inverted and allowed to dry as before. Then they are put into boxes at the packing house, and are put through a sweating



Gathering grapes, California.

process, until the proper aroma is developed. Sometimes the curing process is carried on by steam instead of by exposure to the sunlight.

Among the grapes grown for making wine are the following leading well known varieties: Bertrand, Clinton, Concord, Cynthiana, Herbemont, Ives, Lenoir, and Norton's Virginia. Other varieties well adapted for wine making are the Catawba, Delaware, Elvira, Missouri, Riesling, Niagara, Noah, and the Scuppernong.

The Concord, the Delaware, and the Niagara are popular for general market use.

Hops. — This plant, which belongs to the nettle family, is found growing wild in the United States, in Europe, and in Siberia, along the banks of creeks and rivers. In the State of Washington hops are grown and cultivated extensively. The annual crop

there is estimated at several million dollars' worth. The hop plant is propagated by dividing its roots in autumn and spring. About three plants should be put in a hill, and the hills should be placed six or eight feet apart. As the flowers are imperfect, it is necessary to have staminate and pistillate plants within easy reach of one another. The ground should be well cultivated and kept free from weeds. The plants should be supported by stakes and trained on trellises or arbors.

The principal use of hops is in making yeast, ale, and beer. Hops are also valued for their medicinal qualities. In Germany, England, France, and Austria large quantities of hops are raised only for the purpose of making beer. Many of the brewers in the United States import from Germany the hops they use in manufacturing beer. St. Louis, Chicago, and Milwaukee are the chief brewing centers.

Black Pepper. — The use of pepper dates back to very early times, and it is said to have been known to the Greeks at the time that Alexander the Great completed his conquest of the world. They received the most of their pepper, as we do to-day, from East India and the Malay Islands.

Our black pepper comes from berries about the size of a pea, which are at first green, then red, and finally yellow or black when dead ripe. These berries grow on a climbing plant with large glossy leaves, which is allowed to grow to a height of ten or twelve feet. The plants are propagated both from seeds and cuttings, and are trained on poles or trellis work, and they are set out at the rate of twenty-five hundred to the acre. They begin to bear in their third year, and from this time they usually produce approximately two pounds every year for a period of fifteen or twenty years.

The pepper berries are picked while red and are put in the sunlight to dry, and are left there until they turn a dark reddish brown or black. These dried berries are then ground, and furnish us the ground black pepper of commerce. White pepper is made by removing the pulp of the ripe berry by thorough washing, and then, after drying, the pale gray central portion is ground.

Vanilla. — The vanilla vine grows wild in the eastern part of Mexico, and also in some parts of South America, but it is now culti-

vated in these countries and in some of the tropical islands near them. The plant has smooth, waxy bark and is of a light green color. In planting, shoots about a yard long are set out at the foot of a tree, upon which the vine climbs and grows. At the end of the third year the vines begin to bear small, delicately scented blossoms. Later these drop off and pods about the size of a large banana take their places.

The pods are gathered just before they mature, and are dried and put through a sweat under sheds. This develops and fixes the aroma so characteristic of vanilla. From these pods and their beans is made the vanilla extract of commerce.

EXERCISES

1. Visit a grape vineyard, if possible, and learn all you can about grape culture. Ascertain what varieties have been tried in your locality and the results.
2. Estimate the cost of setting out a vineyard of five acres.
3. Estimate amount of fruit that may be expected and calculate the value when grapes are worth forty cents a basket.
4. Which is more valuable, all things considered, five acres of grapes or five acres of strawberries? Prove your statement.

QUESTIONS

1. Name some of the special vine crops.
2. Discuss grape culture.
3. Name some of the commercial uses of grapes.
4. Name some of the leading varieties of grapes.
5. Discuss hop culture.
6. Name some of the uses of hops.
7. Discuss the culture of black pepper.
8. How is white pepper made?
9. Describe the vanilla vine and its fruit.

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XXXIII. ORCHARD CROPS

OUR orchard crops embrace many fruits that are useful to man. Some of the most important are the apple, pear, peach, plum, nectarine, apricot, cherry, quince, olive, orange, lemon, lime, guava, grape fruit, fig, date, banana; and pineapple.

The Apple. — The many varieties of apples have all probably come from two wild species, native to southwestern Asia, one giving us the common apple, and the other the crab apple. Apples have been cultivated, and esteemed highly, from the most ancient times, but many of our most highly prized varieties are of comparatively recent origin and development. The apple tree thrives best in a deep, cool, moist loam, but it will grow well in almost any soil in which lime is present. When this element is not present, fertilizers containing it should be added to the soil. Apples are grown extensively in Europe, Tasmania, New Zealand, and North America, and especially in the United States. They are extensively grown in North Carolina, Virginia, Pennsylvania, the New England States, Missouri, Oklahoma, New Mexico, Arkansas, Michigan, Indiana, Illinois, Kentucky, Oregon, and Washington.

Apple trees are usually propagated from seedlings by budding and grafting, and it is from these sources that we derive our choicest varieties of fruit. The young trees are usually set out when they are two or three years old, in rows twenty to thirty feet apart, and are carefully cultivated from time to time. The trees must also be carefully pruned each year, and sprayed during the growing season with poisonous fluids to keep the trees free from insects and disease.

When possible the orchard should be protected against the ravages of rabbits by inclosing it with closely woven wire fencing. Some nurserymen either whitewash the trunks of the young trees or place strips of wire gauze around the trees as an additional protection.

Late in the summer, or in the fall, when the fruit ripens, the apples are carefully picked by hand, sorted into the proper sizes, and packed in boxes or barrels ready for shipment.

The chief uses of apples are as dessert fruits, for canning and preserving, and for making jelly, pies, puddings, and dumplings. They are also used for making apple butter, cider, vinegar, and brandy. A great many apples are dried, or evaporated, for winter use.

The Pear. — This tree is often found growing wild in various parts of Europe and Asia. The pear was early brought under cultivation, and there are said to have been thirty-two varieties known to the Romans in the time of Pliny; but it was not until the seventeenth century that any greatly improved varieties were grown. Pears were introduced into the United States by the early settlers, and the Endicott pear tree, planted in 1628, by Governor Endicott, is still living.

The pear tree is a more hardy tree than the apple tree, and it is capable of enduring greater extremes of heat; and hence it grows not only where the apple tree is found, in the Northern States, but also in the Southern States, where the climate is generally too warm for the apple to flourish.

Unlike most fruits, pears have a better flavor if picked while green and ripened indoors. The chief commercial uses of pears are for canning, for making preserves, and for the manufacture of pear cider. In commercial importance it ranks fourth among our orchard crops.

The Peach. — The peach tree is a native of China, where it has been cultivated from very early times. From China, the peach tree was introduced into Persia, and from there it was carried to Europe, and finally to our own country. Peaches thrive in nearly all parts of the United States except in the New England States. We have about three hundred varieties of peaches, and ripe fruit is on the market from May until late in the fall. In the New England States peaches may be grown under certain conditions. Experience has shown that the hilltops in these regions are the best adapted to the peach tree, and the reason is not hard to find. Frequently, when the temperature in the valleys and on the levels is 15° to 25° below zero, it will be only 8° to 10° below zero

on the sides of the hills, and perhaps only zero at the top. This is due to the fact that the cold, heavy atmosphere settles down to the lowest places, while the warm, light atmosphere is forced upward towards the hilltops. For the same reason, frost often kills vegetation of the early spring in the valleys, while plants on the ridges and hills will be uninjured.

Some of the leading peach-producing States are the Lake States, the Gulf States, Southern States, Missouri, Kansas, Oklahoma, New Mexico, Colorado, California, Delaware, and New Jersey. There are probably nearly two hundred million peach trees grown in the United States and Canada.

There are two general classes of peaches: (1) the soft or free-stone peaches, and (2) the plum or clingstone peaches.

Peaches are propagated by budding and are grafted upon seedling stocks. In transplanting, the trees are set twenty feet apart each way, as a rule, and this will require one hundred and eight trees to the acre. When they are set only fifteen feet apart, one hundred and ninety-three trees to the acre will be required.

Peaches are eaten raw, and are also used in making pies, brandy, preserves, and in canning. Many peaches are also dried, or evaporated, and are placed on the market in this form.

Nectarines. — The nectarine is simply a peach having a perfectly smooth skin. The tree has the same pink flowers and the same shaped leaves as the ordinary peach. The nectarine is very susceptible to the attacks of the curculio and the peach-tree borer, and must have close attention if success is expected. Like the peach, it requires a soil of only moderate fertility. Lime, potash, and phosphates are the elements on which the tree draws largely, and hence applications of bone dust and wood ashes will be found helpful to the soil.

The Plum. — The plum tree is probably a native of Asia, but the numerous varieties now grown in this country come from three species: One was found growing in North America when the early explorers discovered the mainland, another was brought from China and Japan, and a third one from Europe. The plum is a near relative of the peach, but is distinguished from it by its beautiful white flowers, its size, its smooth-skinned fruit, and in many other particulars.

The best soil for the plum is a moderately rich clay loam. The European varieties are adapted to the Northern States, the Japanese and Chinese varieties to the Southern States, while the native stocks thrive the best in other parts of our country.

The chief commercial uses of the plum are in making preserves, plum butter, and prunes, or dried plums. Only the large, sweet varieties are used for prunes. These are grown principally in California, Oregon, Washington, and Idaho. In making prunes, the fruit is first washed in warm water, and then dipped into a mild solution of lye to crack the skin, and thus hasten the drying or curing process. The drying may be done either in the sun or by artificial heat.

The apricot is said to be a native of China, Armenia, and Japan. Its fruit resembles both the plum and the peach. The skin is smooth like that of the nectarine, its pulp is somewhat like that of the peach, while it has the smooth stone so characteristic of the plum. It is an attractive ornamental tree, with glossy, heart-shaped leaves and white blossoms. The apricot was introduced into California by the early Mission Fathers, and it is grown more largely there than in any other State. Arkansas, Texas, Oklahoma, New Mexico, Arizona, Alabama, Georgia, Florida, Louisiana, Kansas, and New York also grow a great many apricots.

Apricots are used in making jellies and tarts, and they are also excellent when dried or canned.

The cherry has been known since the days of the ancient Romans. It is said that Lucullus, one of the Roman generals, brought the fruit from Asia to Rome, and from that place it gradually spread all over Europe, and from Europe it was brought to America. There are a number of native species in the United States known as the wild cherry. The black cherry is valued chiefly for its timber, which takes a high polish. It also makes an ornamental tree for parks and lawns. Its bark contains valuable medicinal properties, and is used much in the preparation of cough sirups and tonics.

The domestic cherry trees are of two general varieties, which are both of European origin: the morellos, which are hardy and produce sour fruit, and the hearts, which produce a sweet-flavored fruit. The morellos are grown in the eastern part of the United

States, and especially in New York, and are largely used for canning purposes. The sweet-fruited varieties are grown chiefly on the Pacific Coast. The morellos, or sour-fruited varieties, seem to be best adapted to the Southern States.

In China, and especially in Japan, there are some varieties of cherries that are cultivated only for their flowers. The Japanese hold picnics and outdoor parties under the cherry trees, and their young people treasure up many pleasant memories and associations in connection with these beautiful and attractive trees.

The quince was known to the early Greeks and Romans and was highly esteemed by them as an article of food. The tree is small, hardy, and of medium height, with ovate leaves, and white or pale pink flowers. Its fruit resembles the apple or pear, and when ripe it is of a rich golden yellow color. It cannot be eaten raw, but is usually served either baked or stewed. Its chief commercial value is for making preserves and marmalade.

Quince trees are propagated from the seed, by layers, and by slips or cuttings, made in the spring, at the time the buds



Olives.

pass from their dormant state and begin swelling. A few scattering trees are found in various parts of the United States, but the most important quince orchards are found in western New York.

The olive is one of the oldest fruits known to man, for the Bible records state that the dove which Noah sent forth from the ark after the floods began to subside came back with an olive leaf in its mouth. Among the ancient nations, the olive branch was regarded as the symbol of peace and friendship.

The olive is a low-branching evergreen tree, fifteen to thirty feet high, with dark green leaves and yellowish green fruit, which turns black when ripe. The tree

is a native of Greece, Asia, and Africa. The world's supply of olives is grown in Algeria, Tunis, Italy, France, Spain, Greece, Asia Minor, Mexico, Peru, California, Louisiana, Florida, Georgia, and South Carolina.

Olive trees are propagated from sprouts or cuttings, which, after being placed in beds of moist sand and roots have developed, are set out thirty to forty feet apart each way. They do not begin to bear profitable crops until they are six to eight years old, when the yield is about six gallons of oil to the tree; and this gradually increases from year to year, until the maximum yield of fifty gallons is reached.

The profitable bearing term covers a period varying from thirty to fifty years, but olive trees usually live to be several hundred years old. The ripe or black olives are used for making olive oil, and the green olives are sorted, graded, and pickled for table use. They are put up in bottles, tubs, and barrels, and shipped to all parts of the world.

Olive oil is used in making salads and dressings, also in manufacturing soap. In some of the countries bordering on the Mediterranean Sea it is used in place of butter in cooking.

The Orange. —

The orange tree is a native of Asia, but it is now extensively grown in Florida, and the Gulf Coast country of Louisiana, Alabama, Mississippi, Georgia, Texas, California, and in the Salt River Valley of Arizona.



Orange tree, Florida.

Portugal, Spain, Sicily, Asia Minor, Porto Rico, Hawaii, the Philippines, South America, China, and Japan also furnish large quantities. The tree grows to a height of some twenty or thirty

feet and bears bright green, glossy leaves and highly fragrant flowers. Its fruit is of a golden or yellow color, and is about the size of an apple. It is not an uncommon sight to see an orange tree which has buds just beginning to swell, flowers in full bloom, green fruit, and ripe fruit, all at the same time.

The trees generally begin bearing in February, and the fruit continues to ripen until the summer season is well advanced. The oranges are carefully clipped, or cut, from the branches of the tree, and gently placed in a sack, carried by the picker. When the sacks are filled, they are emptied into baskets or carrying boxes, ready to be carried to the packing house. There the oranges are cleaned, sorted, wrapped in tissue paper, and packed in shipping boxes, ready for transportation to the large market centers. In each box from sixty to three hundred oranges are packed according to their sizes. The large oranges are generally inferior in flavor and quality to the oranges of medium size.

There are about seventy-five varieties of oranges, which fall into two general classes : (1) the bitter oranges, and (2) the sweet oranges. The seedless navel orange, grown in Florida, Arizona, and California, was brought in 1870 from Bahia, Brazil, by the United States Department of Agriculture. It is now one of our most popular oranges.

The trees are budded in the nursery, where they remain for two years, then they are set out in the orchard twenty to twenty-five feet apart. The trees begin to bear when they are about five years old, and if properly cultivated and cared for, they continue to bear for half a century or more.

The orange thrives the best in a deep, fertile loam along the banks of rivers, lakes, and other water courses. Growth is especially stimulated by applying to the soil fertilizers containing lime.

Oranges are highly esteemed as a dessert and for making orange jelly, orangeade, orange sirup, and extracts.

The Lemon. — Lemon trees are grown from lemon buds, grafted on sour orange stocks. They have light-colored leaves and flowers tinged with red, and bear a pale yellow fruit with a sour or acid flavor. Lemons are used for flavoring extracts and sirups, and for making lemonade. They are cultivated, picked, packed, and shipped in the same manner as oranges.

The lime grows wild in the Malay Peninsula and India, and is somewhat like the lemon. Limes are now grown and cultivated in the West Indies, Florida, the southern parts of the Gulf States, parts of Mexico, and other tropical countries. The tree is thorny, and it bears white flowers somewhat smaller than those of the lemon. The fruit is about the size of an apricot and is of a pale greenish yellow color. It has a decided acid flavor.

The grape fruit tree looks very much like an orange tree in its general make-up, but it bears a large globular fruit with heavy, thick rind. The flesh is of a whiter texture than the orange, and is somewhat sour and bitter. It is served raw as a dessert and is also used in making preserves. It is grown in Florida, California, Arizona, the Gulf States, Mexico, and other tropical countries. The grape fruit is a native of the Malayan and Polynesian islands, but it readily adapts itself to practically all regions where oranges are grown.

The fig is a native of Asia and Africa and has been cultivated from the very earliest times. It grows well in Florida, Arizona, California, and in nearly all the low country of Georgia, Alabama, Mississippi, Louisiana, and Texas. The tree is propagated from cuttings from the roots planted in the fall or spring. The trees are usually set from twelve to fifteen feet apart, and they begin to bear the second year. Figs are sold raw for cooking purposes, but many of them are dried and packed in boxes for shipment. They are also used for making extracts and sirups.

Dates. — The date palm thrives the best in Asia and Africa, but it has now been found that it will grow successfully in California and Arizona. Its commercial value in these States lies in the fact that it will grow in regions thought to be worthless for farming, and that it will endure more heat, drought, and alkali than any other plant. The date palms begin to bear at five years of age, but do not come into full bearing until they are ten or twelve years old, and they continue to bear for a hundred years or more. Each plant when mature will bear from three hundred to five hundred pounds of dates. The world's supply of dates comes chiefly from the Persian Gulf regions in Asia, but some reach us from Egypt, Sahara, and adjacent regions.

The guava tree in its size and general appearance is very

much like an ordinary plum tree. It bears white, fragrant flowers and a yellow-skinned fruit. The pulp is crimson or yellow, with a pleasant acid taste. When raw there is a faint suspicion of onion flavor to the fruit. It is much prized for desserts, cooking, and preserving, and also for making jellies and marmalades. The guava tree is propagated by seeds, layers, and cuttings. It grows in Florida, California, Mexico, West Indies, South America, and other tropical lands.

The mango is distinctly a tropical fruit, which grows in Florida, Central America, South America, the East Indies, and in the Philippines. It is sometimes called the apple of the south. The



Boat load of bananas, Central America.

mango tree is large and spreading, with long, lacelike leaves. Its flowers grow in clusters at the end of the branches, and its fruit is about the size of a cucumber or goose egg and varies in color from green to yellow. The usual methods of propagating the mango are by budding, grafting, and by growing from seeds.

The banana plant looks very much like a mammoth cornstalk, about a foot through and from ten to forty feet high. At the top of the stalk is a crown of pinnately veined leaves which spread out and bend over like an open umbrella. These bladelike leaves are not infrequently from six to ten feet long. The fruit

grows in clusters bearing from fifty to one hundred bananas. Each plant bears but one bunch and then dies down to the ground.

Bananas are grown in southern Florida, Louisiana, and California, and are shipped to the United States and Canada in great quantities from the West Indies, Central America, Mexico, and other tropical lands.

Pineapples are grown by setting out suckers which grow at the base of the fruit or from the bunch of leaves growing at the top. The plant is low, attaining a height of only a few inches, and produces sword-shaped leaves, in the center of which the pineapple is found. This fruit is generally from six to ten inches long and from four to five inches thick. Its weight varies from three to twenty pounds, according to the size. It is grown in tropical countries chiefly, but our supply in the United States comes from the West Indies, the Bahama Islands, Florida, and California.

The persimmon is found growing wild in many parts of the United States and especially in Virginia, but it has been only within recent years that any attempt has been made to cultivate or improve any of the wild varieties. We now have more than a dozen cultivated varieties which produce excellent fruit. The tree is somewhat larger than the plum tree and the fruit is about as large around as a silver twenty-five-cent piece, and when ripe it is of a reddish golden color. It is excellent when eaten raw, and when dried it has a flavor somewhat like that of dates.

The papaw known in the United States is a shrub or tree found growing in the Southern and Western States. The tree has obovate lanceolate leaves, and it bears a yellowish pulpy fruit about as large around as a banana, but only about half as long. The pulp is surrounded by a light, thin, green skin, which is easily broken when the fruit is ripe. The flavor of the fruit is generally improved by frost. Experiments made with the papaw indicate that it is susceptible of great improvement under cultivation and careful handling. In the wild papaw the objectionable features are its thin skin, which prevents its being shipped successfully, and its extra large seeds, which make up so much of the bulk of the fruit.

EXERCISES

1. Which do you consider the more valuable, apples or pears? Why?
2. Which is the more valuable crop, peaches or apricots? Why?
3. In setting out cherry trees how many trees should be set to the acre?
4. Estimate the number of trees to the acre for (a) apples, (b) pears, (c) peaches, (d) oranges.

QUESTIONS

1. Name some of the orchard crops.
2. Discuss apple culture.
3. How are apple trees propagated?
4. Name some of the uses of apples.
5. Discuss pear culture.
6. Name some of the uses of pears.
7. Discuss peach culture.
8. Describe the nectarine.
9. Discuss the plum and its culture.
10. Give a brief history of the apricot.
11. Name some of the uses of apricots.
12. Give a brief history of the cherry.
13. Discuss the growing and marketing of cherries.
14. Describe the quince and its fruit.
15. Discuss the olive industry.
16. Give a brief history of the orange.
17. Describe the manner of packing and shipping oranges.
18. What can you say of the varieties of oranges?
19. How are lemon trees propagated?
20. Name some of the uses of the lemon.
21. Discuss (a) the grape fruit, (b) the fig, (c) the lime.
22. Discuss the culture and value of (a) dates, (b) guavas, (c) mangoes, (d) bananas, (e) pineapples, (f) the persimmon.

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XXXIV. NUT CROPS

NUTS constitute an important part of man's food. They are rich and nutritious, and should always be given a place among our articles of diet. There are several kinds of nut trees which are highly esteemed as ornamental shade trees, as well as for the valuable fruit they yield.

Some of the leading varieties are the almond, English walnut, white walnut or butternut, hickory nut, pecan, chinquapin, chestnut, hazelnut, cocoanut, and Brazil nut.



Almond trees.

The almond tree looks very much like a peach tree in its size, foliage, and flowers; but its fruit has hardly any flesh, and almost its whole bulk consists of the stone or seed. When the fruit ripens, the skin breaks open and the pulp dries up. The nuts fall to the ground and are then gathered and put in sacks ready for shipment.

Almonds are grown in the Orient, in Florida, and in California, but the most of our supply comes from Spain and countries near the Mediterranean Sea. Almonds are used in cooking, confectionery, and medicine. The bitter varieties are used in making perfumery and flavoring extracts.

The English walnut is a lofty tree, which begins to bear profitably when it is about six years old and continues to be fruitful for a period of twenty to thirty years. Walnut trees are grown in Spain, England, Italy, and France, and also in California.

The black walnut grows wild in many parts of the United States; it is valuable for its timber as well as for its fruit. It grows to a moderate height and makes an ornamental shade tree. The nuts grow to the size of a silver dollar, but in the fall when cold weather approaches the outer green, pulplike covering turns brown or black and shrivels up, and the walnuts fall to the ground.

The Japan walnut is another variety which forms an ornamental shade tree; its fruit has a delicious flavor.

The butternut or white walnut is a native American tree which bears a nut with a thick, rough shell and a fine-flavored kernel.

The hickory tree is found in many parts of the United States, especially in New England and in the Southern and Western States. It makes a beautiful shade tree, and bears an excellent fruit, sweet and wholesome. The nut is enveloped in a husk, which splits into four thick and hard valves when the fruit is mature. The kernel is surrounded with a thin, flesh-colored or yellowish shell. Hickory trees are now propagated only from seed.

The pecan grows wild in many parts of our country and is cultivated in Oklahoma, Texas, Arkansas, Missouri, Florida, Louisiana, and other southern States. Pecans may be propagated from the seed, but budding and grafting usually give the most satisfactory results. The trees when under cultivation are usually set about forty feet apart. They begin to bear when they are about six years old and continue bearing for twenty or thirty years. There are many valuable varieties, but the most satisfactory variety seems to be the Louisiana or Texas paper shell. Pecans make ornamental shade trees. The nut is of a rich chocolate color.

The chinquapin is usually a shrub or a tree of low height, which

grows wild in the hilly region from Virginia to Alabama and thence westward through eastern Oklahoma and Texas. The nuts are small and have a fine flavor. The kernel is enveloped in a shell of a rich mahogany color.

The chestnut is a large forest tree bearing sweet brown nuts inclosed in prickly burrs. Its named varieties are propagated by grafts which usually begin to bear the second year. It is common to parts of Europe and America.

Hazelnuts grow on shrubs from four to six feet high, which group themselves in thickets. They are found extending from the New England States westward to North Dakota and thence southward to the Gulf. The nut is of a light brown color except at one end, which has a circular spot of a light color. It is used in making confectionery and is also valuable as a forage crop for hogs.

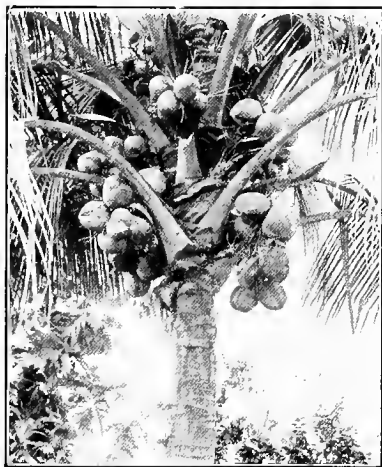
The acorn is the nut of the oak and it is of no special commercial value except as a feed for hogs.

The cocoanut is the fruit of the cocoanut palm, which is widely distributed in all tropical countries, but is never

found growing very far from the sea unless transplanted by man. It has a trunk varying from one to two feet in diameter, which rises to a height varying from sixty to one hundred feet. At the top it bears a crown of pinnate leaves which curve downward.

It begins to bear when about seven years old and continues fruitful for fifty or sixty years. The cocoanuts grow in bunches of five to fifteen at the top of the trunk, and a mature tree will produce from eighty to one hundred cocoanuts annually.

The cocoanut palm is propagated by seed, the nuts being placed in holes about two feet deep, but only partly covered with soil. As the young seedling grows upward, the hole is gradually filled



Cocoanuts.

until it is level with the surface. Finally the seedlings are transplanted to the field or grove and set out twenty-five to thirty feet



Cocoanut palms.

apart each way. The cocoanut tree thrives along the coast country of southern Florida, and extensive plantations are found in that part of the State.

The chief uses of the cocoanut are for making candy and cake and as a flavoring for fruit desserts. It also furnishes an oil valuable in the manufacture of soap.

The Brazil nut grows along the Orinoco and the Amazon rivers in South America. The tree often rises to a height ranging from one hundred to one hundred and fifty feet, and it has magnificent foliage of large dark leaves. The rich

oily nuts are triangular in shape with a hard shell. They are borne tightly packed together in a spherical covering.

COMPOSITION OF NUTS

	WATER	PROTEID	FAT	CARBO- HYDRATES	CELLU- LOSE	MINERAL MATTER
Chestnuts (fresh) . .	38.5	6.6	8.0	45.2		1.7
Chestnuts (dried) . .	5.8	10.1	10.0	71.4		2.7
Walnuts (fresh) . . .	44.5	12.0	31.6	9.4	— 0.8	1.7
Walnuts (dried) . . .	4.6	15.6	62.6	7.4	— 7.8	2.0
Filberts and hazels (fresh)	48.0	8.0	28.5	11.5	— 2.5	1.5
Filberts and hazels (dried)	3.7	14.9	66.4	9.7	— 3.2	1.8
Sweet almonds . . .	6.0	24.0	54.0	10.0	— 3.0	3.0
Pistachio kernels . .	7.4	21.7	51.1	14.0	— 2.5	3.3
Cocoanut (fleshy part)	46.6	5.2	35.9	8.4	— 2.9	1.0
Cocoanut (dried) . .	3.5	6.0	57.4		31.8	1.3
Cocoanut (milk) . .	90.3	0.5	—		9.0	

EXERCISES

1. Ascertain the value at your home market of (a) almonds, (b) walnuts, (c) hickory nuts, (d) pecans.
2. Compare the relative food values and costs of the list given in No. 1.
3. Consult the table in reference to the food composition of nuts and calculate the relative amounts of fifty pounds each of fresh walnuts and chestnuts in (a) water, (b) proteids, (c) fat.
4. Compare the amount of proteids in seventy-five pounds of sweet almonds with that found in one hundred and fifty pounds of fresh walnuts.

QUESTIONS

1. Name some of the leading varieties of nuts.
2. Discuss the almond industry.
3. Discuss the growing and marketing of walnuts and hickory nuts.
4. Describe briefly (a) the pecan, (b) the chinquapin, (c) the chestnut.
5. Discuss (a) hazelnuts, (b) acorns.
6. What can you say of the cocoanut industry?
7. Describe the Brazil nut.
8. Discuss the food value of nuts.

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XXXV. FLOWER GARDENING

THE laying out of the flower garden is an important matter, but it rarely receives the attention it deserves.

A good way to lay off a flower garden is to follow a natural arrangement as far as possible. Do not fill the lawn up closely with bushes and shrubs, but leave the space in front of the house almost entirely open.

The lawn should be set in blue grass or Bermuda grass and white clover, and a border of low flowering plants along the walk may prove attractive. Shrubs should be planted along the fence and near the walls of the house where they will not obstruct the view from the windows. All unsightly objects should be screened by a cover of tall shrubbery or vines. The honeysuckle, the crimson rambler, the Cherokee rose, and the purple wistaria will be found useful for this purpose as well as for the shade they make. The appearance of the shrubbery will be greatly improved if the shrubs are bordered with flower beds of attractive design.

Morning glories or four o'clocks give a pleasing effect when planted along the fence. Chrysanthemums may be used to good advantage along the sides of the house to cover up and screen unsightly foundations. The trees should be grouped along the sides of the yard and in the rear. The view from the front lawn should in general be left free and unobstructed.

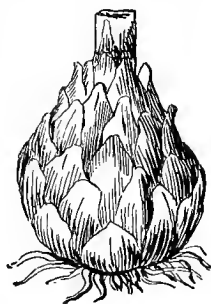
The flower garden should be made in the back yard or at the side of the house. The plants selected should be hardy and self-reliant and of such a nature that a constant succession of flowers may be had from season to season. Among the early spring flowers are the jonquils, sweet violet, Japan quince, periwinkles, early narcissus, daffodils, blue hyacinths, bridal wreaths, wistaria, snowball, white iris, and some of the early varieties of lilies. Among those that grow during the warm dry season are the hollyhocks, four-o'clocks, larkspurs, mallows, phlox, bachelor's buttons, and black-eyed Susans. Among the fall flowers are the

chrysanthemums, verbenas, scarlet sage, canna, cosmos, and marigolds.

Classification of Flower Garden Plants. — In a general way we may group the plants ordinarily found in flower gardens as follows: (1) shrubs, (2) bulbs, (3) corms, (4) tubers, (5) rhizomes, (6) herbs, (7) vines. By a proper combination of these plants we may have beautiful lawns and flower gardens from early in the spring until late in the fall.

Shrubs. — There are many kinds of shrubs that can be grown easily, but one of the most common and satisfactory shrubs will be found in the common lilac. It makes an ornamental bush and bears great bunches of fragrant lavender-colored flowers. It requires but little care, grows rapidly, and is healthy and long-lived. The Japan quince with its glossy foliage and rich scarlet flowers makes a good hedge or border screen. The weigelas with their large bushes loaded down with red, rose, and white flowers in June and July always prove attractive wherever they may be placed. The double-flowering plum, the flowering almond, and the flowering currant are also very attractive shrubs. For late blooming the hydrangea will be found very satisfactory. The syringa or mock orange is a popular plant which grows to a height of eight or ten feet and bears fragrant white flowers in great profusion. The flowering sumach, the purple-leaved barberry, and the elders are frequently used to good effect. Besides the plants just mentioned there are many varieties of roses that should adorn every lawn and garden. For porch screens and arbor effects nothing better can be found than the crimson ramblers interspersed with yellow and white ramblers.

Bulbs. — A bulb may be regarded as a bud with fleshy scales on a short stem. The onion is a good example of a bulb with which every one is familiar. The bulb of the wild lily is likewise a good example.



Bulb.

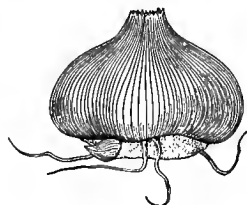
As a rule they produce flowers earlier than other plants. The snowdrops begin to bloom at the very beginning of spring and are closely followed by the hyacinth, the narcissus, and the tulip.

In warm climates bulbs may be set out any time between the last of September and the middle of November, and this will give them time to establish themselves well before the winter begins. In cold climates the bulbs should be dug up and stored where they will not freeze.

In making beds for bulbs we must have good rich soil and good drainage. The ground should be well spaded and mixed thoroughly with loam, sand, and well-rotted manure. Some gardeners dig out a deep pit and place at the bottom of this a loose layer of coarse gravel and then fill the pit with soil prepared as suggested above. This drains off the surplus water, which would hinder the growth of the bulbs. If the bulbs are left in the ground over winter, they should be covered in the fall with six to eight inches of straw litter or dry leaves in order to protect them from freezing.

Bulbs can be used to good effect to dot the border of shrubs and rose bushes, and many prefer this arrangement to having them in beds.

Corms resemble bulbs and are often called bulbs, but they are really very short and thick fleshy subterranean stems having buds called cormels which usually grow out from the base and become independent corms in a single season. Common examples of corms are found in the Indian turnip or Jack-in-the-pulpit and the crocus.



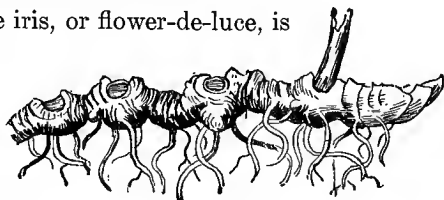
A gladiolus corm.

In general, corms may be handled in the same way as bulbs. They produce attractive showy spring flowers and should be found in every garden. The crocus is one of our earliest spring flowers, which produces dense masses of richly tinted blossoms. Other attractive plants produced from corms are the cyclamen, the common gladiolus, the giant-flowered gladiolus, and the butterfly gladiolus.

Tubers are short, thick rootstocks having eyes or buds along the sides of the underground stem. They grow best in rich, sandy, and well drained soil. In this list may be mentioned the different varieties of begonias and the tuberose.

A **rhizome** is a creeping stem or branch growing beneath the

surface of the soil or partly covered by it. A good example is found in the common peppermint or in Solomon's seal. The sweet flag, which grows in wet grounds and sends up double-edged, sword-shaped leaves, has an aromatic rootstock and flowers early in the summer. The iris, or flower-de-luce, is another good example of a hardy rhizome. Some of the best-known varieties of the iris are the blue flag, the yellow iris, Japanese iris, dwarf garden iris, and Persian iris.



Rhizome.

They are often used for border effects along walks and around flower beds.

Herbs are plants with stems that die down to the ground every year after blossoming and at the approach of cold weather. These are grouped by florists as annuals, biennials, and perennials, and each of these groups are subdivided in three subclasses as follows:

GROUP I	GROUP II	GROUP III
A. Annuals	B. Biennials	P. Perennials
1. T.A. Tender Annual. Temp. 60°-80°	Tender Biennial Temp. 60°-80°	Tender Perennial Temp. 60°-80°
2. H.H.A. Half Hardy Annual Temp. 50°-60°	Half Hardy Biennial Temp. 50°-60°	Half Hardy Perennial Temp. 50°-60°
3. H.A. Hardy Annual Temp. 40°-45°	Hardy Biennial Temp. 40°-45°	Hardy Perennial Temp. 40°-45°

Of the annuals there are several hundred varieties which may be grown with but little difficulty. The China asters, California poppies, candytuft, balsams, hibiscus, phlox, petunias, pinks, sweet peas, nasturtiums, verbenas, morning-glories, mignonette, sweet alyssum, chrysanthemums, datura, larkspurs, marigolds, and zinnias are annuals that may be grown easily. The list of bien-

nials is not so large, but the double white canterbury bell, the double blue canterbury bell, and the foxglove usually give very satisfactory results.

The list of perennials is quite large and some of them should be found in every flower garden. Among those that may be grown easily are the carnations, bluebells, coleus, cyclamen, dahlia, forget-me-nots, geraniums, hollyhocks, oxalis, peony, perennial phlox, Japanese bellflower, petunias, pinks, smilax, snapdragon, sweet William, and verberna.

Vines. — A very graceful finish may be given to the porch or to the sides of the house by a judicious arrangement of vines or climbers. The morning-glory and the cypress vine are strong, rapid growers. The Japan hopvine and the flowering bean have also been found quite serviceable in some parts of our country. The latter has rich scarlet flowers which are very attractive. The Dutchman's pipe, the bignonia with its rich, glossy, green leaves and orange-scarlet flowers, the various kinds of honeysuckle vines, the clematis, and the wistaria with its long purplish blue or white flowers, are all valuable climbing plants. They will be found serviceable as screens for fences, back yard walls, arches, arbors, and covered walks.

Care of Flowering and Ornamental Plants. — It is not enough to set out plants and then leave them to shift for themselves, but they must be given careful attention from time to time. All weeds must be removed as fast as they appear, and the soil must be kept loose on the top so that it will not form a dry, crusty layer. In loosening the soil care must be taken not to stir the ground too deep.

The soil should be enriched each growing season with leaf manure or well-rotted barnyard manure to which a little sand and loam have been added. When the plant is dormant, no fertilizer is needed and none should be used. The dormant plant would be excited by it and would start an unnatural and premature growth.

For pot plants or house plants occasional applications of liquid manure will be found beneficial. It may be prepared by pouring hot water over dry cow manure. When this has drained off, place the manure in a flour barrel with loose-fitting staves and pour cold water upon the contents until the liquid begins to run

out through the openings of the barrel. This is the liquid manure which should be applied to the soil. Before using, dilute the liquid until it is of a pale yellowish amber color. Applications should not as a rule be made oftener than every ten days or two weeks. A teaspoonful of bone meal or bone dust every month is sometimes found beneficial to ordinary pot plants.

Should the plant become sickly on account of the presence of larvæ or worms in the soil, it will be found advisable to thoroughly saturate the soil with clear limewater. This will drive out the worms and will not injure the plant. If no manure is used without being first thoroughly scalded with hot water, there will be no likelihood of trouble from worms, as the larvæ will be killed by this treatment. If the leaves become diseased, dissolve some copperdine in water and spray the plants from time to time until the disease disappears. An occasional use of the spray is also advisable with healthy plants in order to ward off diseases of a bacterial or fungous nature. A soapsuds spray will be found effective as a simple home-made insecticide. For the mealy bug and scale, applications of lemon oil or of fir-tree oil will be found best.

In watering plants great care must be taken. Many plants are killed by overwatering and overzealousness on the part of amateur florists. Always stir the soil first with your finger, and if it appears dry and dusty on top, the plant needs watering; if the soil appears damp, heavy, or sticky, the plant needs no watering. Plants should be looked after every day. Generally the best time for watering plants is late of an evening. During the warm season it should never be attempted during the middle of the day.

Window Gardening. — In the cities it frequently happens that room cannot be found for an outdoor flower garden, but in such cases the housekeeper may find a great deal of pleasure in having a small window garden. When a choice of windows can be had, it will be best to take one facing the south in order that the plants may have all the sunshine possible.

The window may be fitted up to receive the plants by attaching to the wall under the window a board shelf supported either on iron brackets or wooden supports. If the plants are to be placed outside, it is best to replace the shelf with a window box and set

the pots of plants in it. If small ornamental plants are to be placed on the sides of the window, it will be best to purchase regular pot brackets.

The window garden may be further enlarged by the addition of a hanging basket suspended from the top of the window and a plant stand placed underneath the window on the floor.

Keep the plants well watered, give them plenty of air on warm, sunny days, but avoid exposing them to cold drafts on cold days. If possible, avoid placing the plants in a room where natural gas is used, as the fumes from the gas and its oppressive dry heat will prove injurious.

Among the plants that may be found attractive in window gardens may be mentioned the following: ageratum, amaryllis, azalea, abutilon, begonia, baby primrose, chrysanthemum, carnation, calla, Chinese primrose, cyclamen, daphne, fuchsia, geranium, hydrangea, hibiscus, heliotrope, olea, petunia, stevia, salvia, and the valotta.

As basket plants the following will be found useful: othonna, oxalis, saxifraga, moneywort, linaria, vinca, lobelia, and the trailing lantana. Among the trailing plants the following will be found quite satisfactory: English ivy, German ivy, passion flower, hoya, jasmine, and thunbergia. Among the foliage plants are the palm, fern, aralia, begonia, dracæna, variegated geraniums, and the pandanus.

EXERCISES

1. Submit a plan for a flower garden.
2. Secure a catalogue from some good seed house and study the cost and adaptability of various kinds of flowers.
3. Make lists of spring, fall, and winter plants for the flower garden.
4. Determine the best assortments for (a) an outlay of five dollars, (b) an outlay of ten dollars.
5. Make a list of plants growing at your own home and estimate the amount of the investment.

QUESTIONS

1. Discuss the importance of the flower garden.
2. Describe the general arrangement of a lawn.
3. Name the classes of flower garden plants.

4. Discuss the arrangement of shrubs.
5. Discuss bulbs and their uses.
6. Describe (a) corms, (b) tubers, (c) rhizomes.
7. Discuss the general classes of herbs.
8. Name and describe some ornamental vines.
9. Discuss the care of flowering and ornamental plants.
10. What can you say of window gardening?

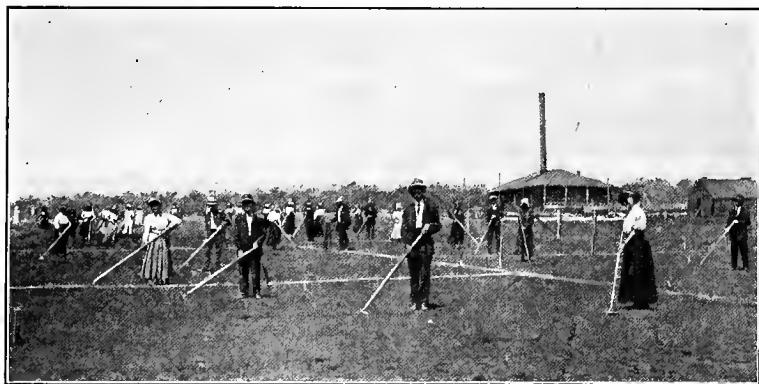
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XXXVI. CIVIC IMPROVEMENT

SCHOOL GARDENS

THE United States Government maintains a large model school garden at Washington, D.C., that should be visited by every teacher who visits Washington. Other good school gardens may be seen at the State normal schools in Hyannis, Massachusetts; Kirksville, Missouri; Edmond, Weatherford, and Alva, Oklahoma; and San José, California. Among the most attractive and the



School garden, Weatherford, Okla.

best arranged gardens in the United States are those belonging to the boys of the National Cash Register Company at Dayton, Ohio. They are models of neatness, and no one can see them without being greatly impressed with their value and importance. The idea has taken firm hold there, and nearly all of the children spend their spare time either in the school gardens or in their small private flower gardens at their own homes.

Each garden is generally made ten feet wide and seventy feet long when sufficient ground is available.

In some of the regular school gardens the plats are laid off ten feet wide and twenty-five feet long, with the rows running north and south in order that the sunlight may be evenly distributed.

For the lower grades in the school it will be found best to have one general garden or bed for the whole grade, but in the higher grades of the public schools and in normal schools there should be individual gardens. It is best to have both vegetables and flowers in the gardens so that the æsthetic as well as the practical side will be impressed upon the pupil. Before beginning the work, draw a diagram on the blackboard, showing the size of the grounds, the size of each plat, and the location of the walks. Then explain about the kinds of seeds that are to be planted, how deep they should be covered, and what is needed to make them grow.

After the ground has been plowed or spaded and put in thorough condition, have each individual garden measured off and staked out with a good strong stake at each corner. Finally number the gardens and assign them in order to the pupils. Next lay off each plat into convenient rows and widths according to the kinds of seed to be planted.

PLAT No. 1

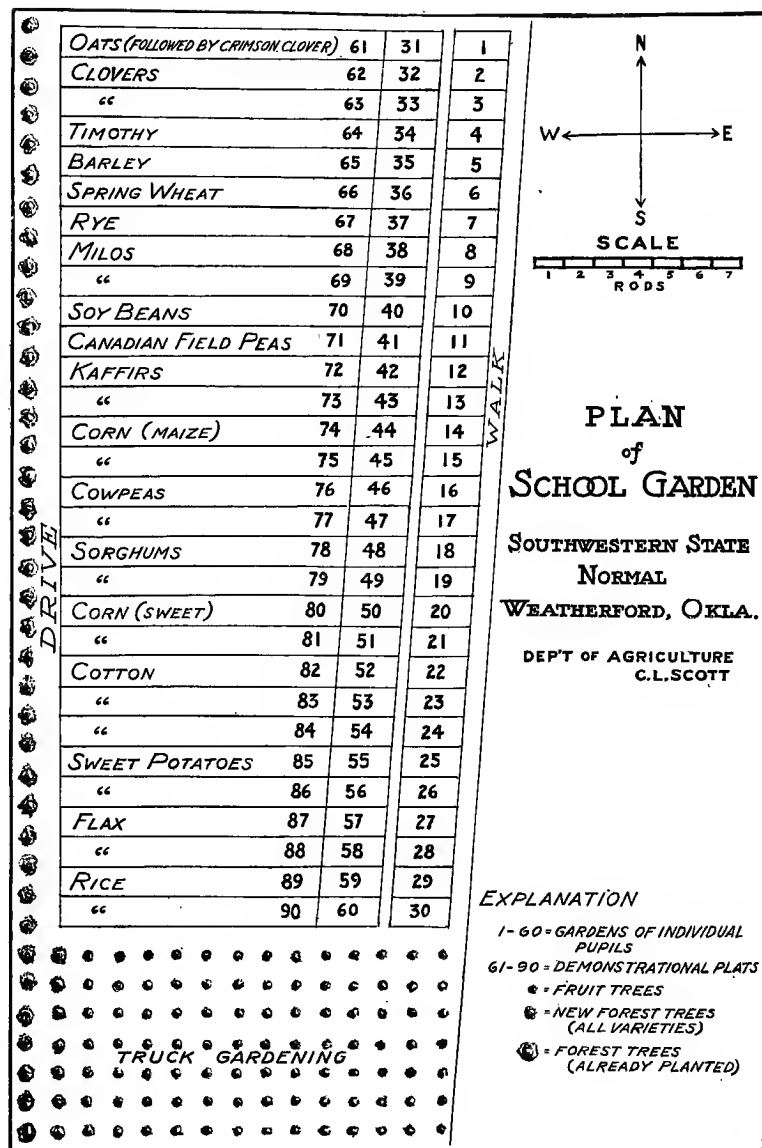
String Beans
Tomatoes
Beans or Peas
Radish
Onions
Radish
Lettuce
Tomatoes
Stocks or Sweet Peas
Asters
Pinks
Dwarf Nasturtiums
Pansies, Violets
Verbenas

A PLAT FOR A GIRL'S GARDEN

PLAT No. 2.

Corn
Shell Beans
String Beans
Radish
Onions
Lettuce
Tomatoes
Radish
Radish or Beans
Beets
Lettuce
Asters
Pinks
Verbenas

A PLAT FOR A BOY'S GARDEN



Other vegetables may be substituted for those named above according to the tastes of the teacher and the pupils. Potatoes and onions of various kinds may be grown and comparative estimates made of the relative productivity of each kind. Strawberries will also be found interesting and instructive for school garden work.

In normal schools the work in the gardens may be laid out on broader lines and may partake more of the experimental side. One student may make tests to determine the most suitable and most productive kinds of seed corn, another student may make experiments with different kinds of lawn grass, and so on.

PLAT No. 3

Blue Grass A	Bermuda Grass B	Timothy Grass C	White Clover D	Red Clover E	Common Alfalfa F	Swedish Alsike G
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DEMONSTRATION GARDEN FOR LAWN GRASS

Experiments with vegetables will also prove interesting and instructive. Below is given a suggestive demonstration plat for onion gardening.

PLAT No. 4

Southport Red Globe	Southport Yellow Globe	Mammoth Yellow Spanish	American Silver- skin	Giant White Italian Tripoli	Mammoth Silver King	Potato or Multiplying Onion
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DEMONSTRATION GARDEN FOR ONIONS

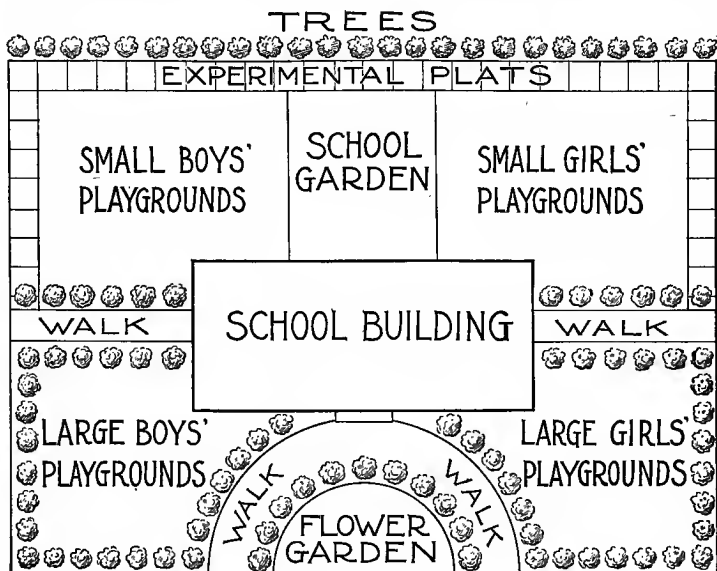
THE SCHOOL GROUNDS

In many places the schoolhouse and the school grounds are the most unsightly objects in the neighborhood, but this is a condition that is fast disappearing. The old log schoolhouse with its split log benches is a thing of the past. A great deal of attention is also now being given to the arrangement and ornamentation of the school yard.

When land is to be had at but little expense, there is no reason

why the school grounds should not contain from two to five acres of ground. This will afford reasonable space for separate school gardens and separate playgrounds for boys and girls.

Teacher and pupils should bend every energy and effort to make the school grounds neat and attractive. Nurserymen will frequently donate trees and shrubs for this purpose. The native trees and shrubs of the vicinity may be utilized to good advantage, and should be used. Begin this work now, and each year arrange



Plan for school grounds.

for suitable tree-planting exercises on Arbor Day and invite the whole neighborhood to join you in the work.

Let the schoolhouse be shaded with trees and the lawn set out in Bermuda grass or some other hardy grass. Hide the unsightly outbuildings, walls, and fences with the Virginia creeper or morning-glory vines. Place a number of large trees in the back part of the yard for a background and dispose about them appropriate groups of shrubs. Arrange the flowers in beds and borders

and where they will not encroach upon the children's playgrounds. Let the playgrounds be supplied when possible with swings, seesaws, horizontal bars, vaulting poles, ball grounds, and everything necessary for the comfort and enjoyment of the children.

Study and criticise the design given here and then make a model plan of your own.

When possible, it will be found a good plan to have the children visit neighboring schools and note the arrangement of the grounds. Encourage them to make suggestions for improving upon the arrangement, whatever it may be. Some attention should also be given to the schoolhouse and its general plan.

CIVIC IMPROVEMENT CLUB

It should be the business of this club to devise ways and means for the improvement of country schools, churches, roadsides, homes, and country life in general. It should be alive to every social and æsthetic interest of the community and must be active in useful ways if it is to be successful. The membership of the club need not be restricted to any particular class. Generally it will fall to the lot of the school-teacher to assume leadership in this matter, and to make the original call for the organization of the club. The first meeting may be held in the schoolhouse, and at this meeting let the club organize by electing a president, vice president, secretary, and treasurer. A constitution should be drawn up by a special committee appointed for that purpose and should be adopted either at the first meeting or at a special meeting called subsequently for that purpose. The Civic Improvement Club may be made a very potent factor for the teacher's success in every community where one is organized and properly managed.

BOYS' AND GIRLS' CONTEST CLUBS

In every district there should be a local boys' club organized to further agricultural knowledge, and contests calculated to stimulate interest in agricultural work should be arranged. In Nebraska, Oklahoma, Illinois, and several other States much interest has been aroused by the corn contests and the prizes

offered for the best home-grown seed corn. These prizes are usually awarded at the State and county fairs under the auspices of the State Superintendent of Public Schools and the State Board of Agriculture. In North Carolina a series of contests in woodwork has been arranged, which has been found profitable as well as interesting. In other States the attention of the boys has been given to live stock and poultry.

The contests for girls, of course, have been along different lines. Sometimes prizes have been offered for work in plain or fancy sewing, for making bread, cakes, jellies, preserves, etc., or for growing fine varieties of flowers or vegetables.

Both boys and girls can join in friendly home lawn improvement contests, and frequently a prominent merchant or business man can be prevailed upon to offer prizes for the neatest and best-kept lawn. Such a movement is always beneficial in any community, and it is one in which every teacher should take a vital interest. The local boys' and girls' clubs may unite to form township clubs, with monthly meetings; and the township clubs may unite to form county clubs, with annual meetings, under the direction and supervision of the County Superintendent and the State Superintendent.

THE NATIONAL COMMISSION ON COUNTRY LIFE

Realizing the need of a national movement for the betterment of country schools and country social life, President Roosevelt, in August, 1908, appointed a National Commission on Country Life, composed of L. H. Bailey of New York, Henry Wallace of Iowa, Kenyon L. Butterfield of Massachusetts, Gifford Pinchot of Washington, D.C., Walter H. Page of North Carolina, William A. Beard of California, and Charles S. Barrett of Georgia, men well fitted for the task before them.

The Commission elected L. H. Bailey, Chairman. E. W. Allen, of Washington, D.C., was engaged as Executive Secretary. Norval D. Kemp, of Dayton, Ohio, was chosen Secretary to the Chairman. The Commission, at its meeting on October 1, declared that its function was to make as thorough a preliminary investigation as possible, to ascertain the main deficiencies of country life, to

state what agencies now exist to correct these deficiencies, and to indicate what further activity is necessary to create a broad, satisfying, permanent rural life.

The Commission began its work by sending out inquiries to the county superintendents, city superintendents, state superintendents, teachers, and prominent citizens, in reference to conditions of country social life. The more than 100,000 replies received were encouraging, and valuable suggestions were gathered.

President Roosevelt then requested the Commission on Country Life to ask the farmers and other country people to meet in their schoolhouses, on Saturday, December 5, 1908, to discuss the questions on which the Commission desired information. This met with such a generous response that a second meeting was set in all the States, for March 4, 1909, to be known as Farmers' Day throughout the Union. The meetings were held in nearly all of the States designated, except in Oklahoma, where the date was set first for March 11, and finally for May 5 and 6. At the suggestion of the national commission the Oklahoma meeting as set for May was made a general meeting for all the States of the Southwest. Following up the suggestion, State Superintendent E. D. Cameron and Governor C. N. Haskell, of Oklahoma, issued a call for the meeting and organization of the Southwest Interstate Commission on Country Life, and invited Louisiana, Arkansas, Missouri, Texas, Arizona, New Mexico, California, Nevada, Utah, Colorado, and Kansas to send delegates and take part in the work. The call met with a generous response, and an enthusiastic meeting was held. Preceding the convention, meetings were held in all of the States, at the schoolhouses, on April 30; and in Oklahoma, especially, strong resolutions were passed, looking to the improvement of country life. The Southwest Interstate Commission on Country Life, as organized at Guthrie, accomplished much good and awakened much enthusiasm, which is crystallizing in the National Association on Country Life now forming. Both organizations will prove powerful factors in the future for the upbuilding and strengthening of our nation. Superintendent Cameron is to be strongly commended for taking the lead in organizing the Southwest Interstate Commission on Country Life.

QUESTIONS

1. Discuss the growth of the school garden movement in the United States.
2. Discuss the plan of a garden for a grammar school.
3. Submit plans for (a) a girls' garden, (b) a boys' garden.
4. Discuss the advisability of having demonstration gardens.
5. Discuss the arrangement of the school grounds.
6. Make a drawing of the plan of your school grounds and suggest improvements. Bring a plan of your home grounds, with the names of the various trees, shrubs, and flowers. Ask how it can be improved.
7. Discuss the need of civic improvement clubs.
8. What do you think of boys' and girls' contest clubs?
9. Give a brief account of President Roosevelt's Commission on Country Life.
10. Discuss briefly the Southwest Interstate Commission on Country Life organized in Oklahoma.
11. What other States have been active in this movement?
12. What are the leading problems facing the people in your community? What agencies are helping to solve these problems? In what ways can the school boys and girls be most helpful?

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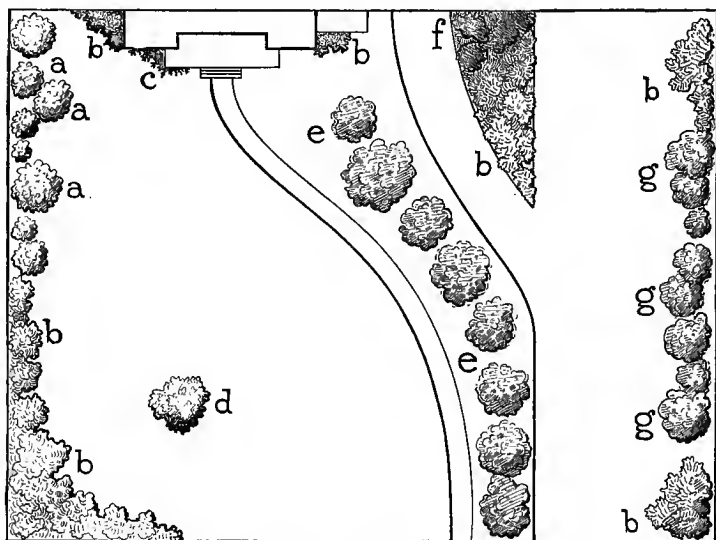
XXXVII. LANDSCAPE GARDENING

THE growing of trees, shrubs, and flowers for their combined or mass effects in lawns and parks, etc., is termed landscape gardening. It is eminently a fine art and is worthy of serious study. It is true that we cannot all become professional landscape gardeners, but we can give some attention to the work in laying out our lawns and in planning our homes. We may not be able to afford the services of an experienced landscape gardener, but this does not justify us in leaving our yards perfectly bare and in making no effort to improve and beautify them by setting out a few trees and shrubs. When trees and shrubs can be had at such little expense, there is no good reason why we should not beautify our lawns. It is not enough to simply set out trees here and there, but there must be some order and system about the arrangement.

The Design. — We must have a plan or a design towards which we must work in grouping our trees and shrubs. One of the cardinal qualities of artistic composition in landscape gardening is *unity* and another is *coherence*. By unity we mean that some one idea shall prevail throughout, although it may not be immediately apparent to every observer. All the details must be subordinate to this one idea, and every item of composition must be added with this thought constantly in mind. In addition to unity we must also have coherence. Thus a number of objects of the same sort placed together may secure unity and yet at the same time not satisfy the eye as to the arrangement. Another quality is necessary, and this is coherence. Our objects must be grouped so that they harmonize. Even many dissimilar objects may be frequently grouped together in self-satisfying unity if they have some obvious underlying connection by which they cohere. To secure thorough unity and coherence, the entire work in landscaping should be under the control of one person, who should have from the start a clear conception of his problem.

The Plan. — In every case it will be found best to have a definite

plan in mind fully worked out before attempting to make any change in the grounds. This plan should be made on paper while the idea is yet fresh in the mind. The unrecorded ideal is likely to change in time, and since the work of landscaping may require several seasons or even years for its completion, the first part of the plan may be out of harmony with the latter part before the work is completed. Professor Waugh, in *Landscape Gardening*, says: "The plan should be drawn with good inks on the most durable



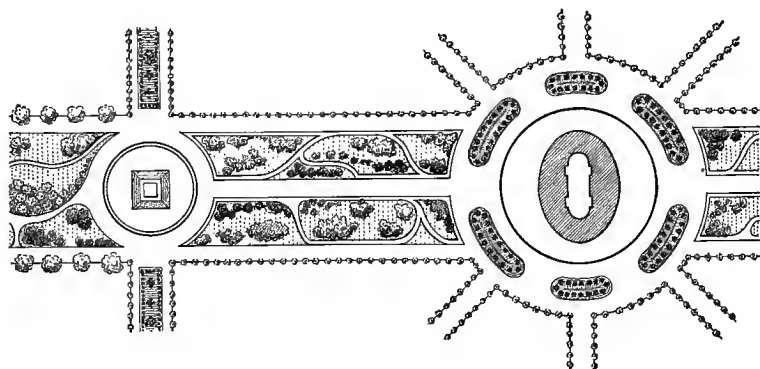
Suggestions for a farmyard (Prof. Waugh).

a, Sugar maples; *b*, shrubbery; *c*, climbers on the porch; *d*, hawthorn; *e*, elms; *f*, basswood or horse-chestnut trees; *g*, sycamores.

paper; and it should be supplemented by written specifications made equally durable. These plans and specification cannot descend too deeply into the minutiae of the composition; for an unsympathetic treatment of the smallest items may mar irreparably the grandest conception." Plans and specifications are none too explicit if they locate and name every tree, shrub, bush, vine, and every flowering plant that is to be used on the lawn. In selecting your plan adopt something that will be in harmony with the residence and the surroundings.

Styles of Landscape Gardening.— There are two great styles or types of landscape gardening; one is the *natural*, and the other is the *geometrical* or *architectural*.

The natural style is sometimes called the *English style* from the fact that it received its first great development at the hands of the early English gardeners. It is the one generally favored for country homes and schools in England, America, Germany, and France. In brief this plan contemplates that the order of nature shall be followed as largely as possible. Let the lawns be as large and as uninterrupted as the surroundings will permit. The view from the front part should be open and unobstructed, and the trees and

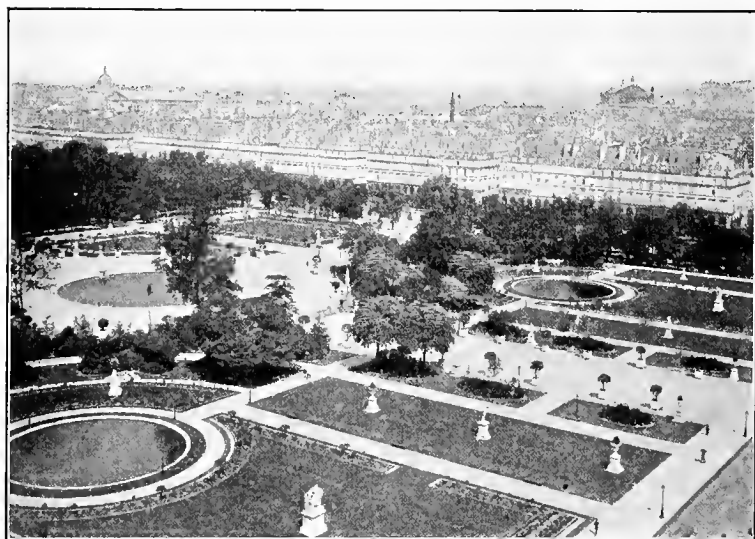


Plan of a boulevard in a Western city.

shrubs should be placed along the sides of the lawn near the fence. The location of the buildings will be determined in part by the lay of the grounds and the taste of the individual. The walks and drives must be carefully planned, and in no case should they lead through the middle of the lawn or follow severe straight lines. Nature works on curves, and straight lines are decidedly unnatural. Usually a double curve is more pleasing than a single curve when the distance traversed will admit of such an arrangement. The trees should be placed in groups and never set in rows if we wish to produce a natural effect. The shrubs should be arranged in a natural way to hide the trunks of the trees; and they also produce a pleasing effect if irregularly grouped along the walls or if they are massed in the retreating angles of the house. Climbers may

be occasionally combined judiciously with shrubs to harmonize the general effect.

In some parts of the United States it may be found necessary to substitute other trees for those given in the above design. Each student should make a pencil sketch of the plan of the grounds of his home, showing the location of residence, trees, shrubs, walks, and outbuildings, and then let him make suggestions for any improvements that may seem advisable. Students should also prepare original plans and designs for lawns and school grounds and submit them to the teacher and the class for criticism.



Geometrical design.

The **geometrical style** is also known as the *architectural* and the *Italian style* on account of its high development among the Italian artists. In this method the trees are set out in straight rows and the grounds are laid out in squares, circles, triangles, crescents, and other geometrical designs. The trees are set out in rows parallel to the road and at uniform distances apart. The trees should also be of a uniform shape and size. Clipped hedges will be found attractive as borders and fences. In parks, terraces, stairways, and balustrades may be introduced to good effect. Fountains and

flower beds are very appropriate in this style of landscape gardening. In large parks lakes and lagoons always give a pleasing effect to the landscape. The rustic bridge, rustic garden seat, summerhouse, boathouse, and greenhouse all add to the beauty and attractiveness of any park and should not be overlooked. In all our large cities, like New York, Chicago, Cleveland, Richmond, Atlanta, New Orleans, San Antonio, San Francisco, Seattle, Omaha, St. Louis, and Washington the student will find many large and beautiful parks which should be visited and studied



In a tropical city.

closely. Some of the cemeteries in these cities will also prove interesting studies in landscape work. The grounds surrounding the hospitals, asylums, and public buildings in nearly all of the large cities are models of landscape art and are worthy of notice. In cities the streets should be wide enough to provide for a system of parking on both sides of the street. If rows of trees and a few ornamental shrubs and plants are set in the parking, the appearance of the streets will be much improved. The garden boulevard calling for an avenue of three or four hundred feet in width is always a very attractive feature in any city. Much of the great beauty of Paris, Edinburgh, and Washington is due to the wide

avenues, splendid parks, and beautiful boulevards that are found in these cities.

In the West the parks of St. Louis and Chicago are deserving of special mention. No visitor in Chicago should fail to visit Lincoln, Jackson, and Washington parks, and the beautiful grounds of the University of Chicago. The beautiful Midway Plaisance connecting Jackson Park and Washington Park in Chicago cannot fail to impress any one with its grandeur and beauty.

In the South there are several cities in which splendid examples of the landscape gardener's art may be found. A very elaborate



Palmetto grove.

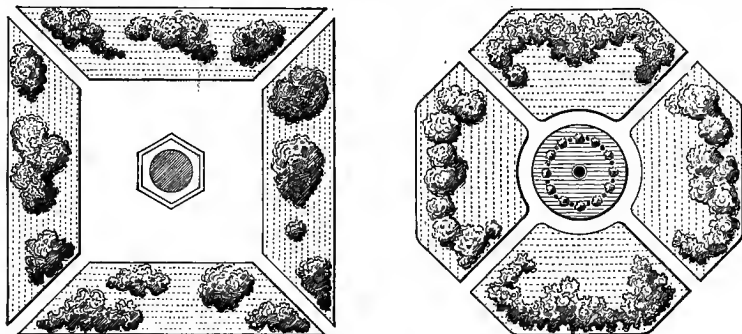
design will be found in the grounds of Belmont College at Nashville, Tennessee. Other fine examples are found in Florida, at St. Augustine, Palm Beach, Daytona, and Tampa.

In many of the cities on the Pacific Coast will be found beautiful examples of fine landscape work. The parks of Los Angeles, San Francisco, Santa Rosa, San José, Fresno, Portland, and Seattle are of unusual beauty and merit.

In many of our smaller towns, where large expensive parks cannot be afforded, the citizens have shown commendable pride by providing a town square in which is frequently located the county

courthouse, city hall, or some other public building. In some cases the public building is not present, and in its place will be found a pavilion or band stand. Such squares or plats can be made very attractive if properly arranged.

The square and the octagon are the favorite geometrical plans for these small parks. When possible it will be found advisable



Designs for town squares.

to inclose the square with a fence to keep out dogs and rabbits, the worst enemies known to low flowers, shrubs, and evergreens. The plat should be placed under the care of some reliable person and should receive attention from day to day.

EXERCISES .

1. Let each pupil submit a drawing showing the plan and general arrangement of the grounds at his own home.
2. Let the pupil submit a second drawing suggesting improvements in the first plan submitted.
3. Let each pupil submit a plan or design for beautifying the school grounds.
4. Request the boys to organize a Boys' Contest Club and help them to plan the work for the same.
5. Request the girls to organize a Girls' Contest Club and assist them in starting the work.
6. Urge the ladies of the community to organize a Domestic Science Club and ask the men to organize a Civic Improvement Club.
7. Arrange for excursions to some educational center and let each pupil make a special report on a certain subject. A trip to your State A. & M. college, your State university, or to one of the State normal schools will certainly be interesting as well as beneficial.

QUESTIONS

1. What is landscape gardening?
2. Discuss its importance.
3. Discuss the need of unity and coherence in the landscape design.
4. Name the styles of landscape gardening.
5. Discuss the natural style.
6. Discuss the geometrical style.
7. Name some cities where examples of each style may be found.
8. Discuss the town square and its usual designs.

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Beautifying Country Homes, J. Weidemann.
Landscape Gardening, E. A. Long.
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XXXVIII. FORESTRY

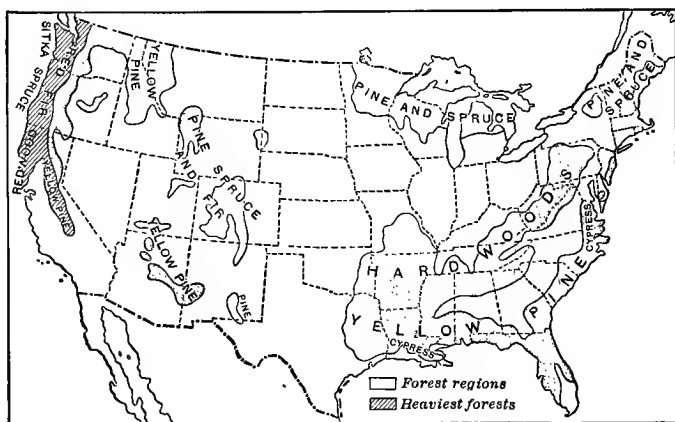
IN a general way every one has some idea of what is meant by forestry. It does not deal with individual trees, but with an assemblage of trees; and for this reason Professor Coulter of the University of Chicago suggests that forestry be defined as the management of woodland, not only for timber that will be afforded, but also because of its important relations to climate, water supply, soil preservation, and the beauty of our natural surroundings.

In the settling of new sections of our country forests were looked upon as obstacles to farming, and the first care of the settler was to cut down the trees and clear the farm. In this way much valuable timber was wasted. We may not appreciate the value of trees until we visit treeless countries as China, Korea, and parts of India and Egypt, where the people have but very little fuel for making fires and often suffer severely from cold weather. In these countries the laborer is fortunate if he secures a basket of the roots of shrubs for his evening fire. Even the refuse from the stable is collected, dried, and used as fuel.

Unless proper measures are taken to protect the forests in the United States, we shall soon reach a point when the supply of timber will be wholly inadequate to furnish the lumber needed for building our houses and for supplying our factories. The paper required for printing our daily and weekly newspapers is made from wood pulp, and thousands upon thousands of trees are required for this purpose every year. Because of the scarcity of wood pulp the price of paper has advanced, and many popular magazines have found it necessary to advance their prices. We are just beginning to look for substitutes for wood pulp. Large quantities of trees are consumed in the manufacture of matches, railroad ties, piles, fence posts, furniture, and building materials. In many parts of the United States a great deal of timber is used as fuel. The demands made upon our forests from all these sources in a year is said to be three times as great as all the timber supplied by one

year's growth of all the trees in the United States. At this rate it is only a question of a short time when all the forests in our country will be destroyed, unless measures are taken to protect and increase our supply of trees and public forests.

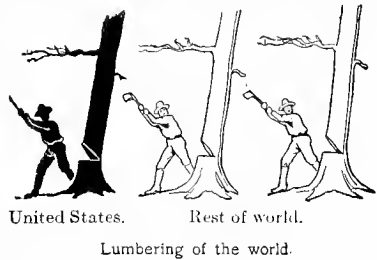
National Forests.—Realizing the danger threatened to our country from destruction of forests, Congress, in 1891, authorized the President to establish forest reserves, or national forests, and President Harrison created the Yellowstone Forest Reserve that same year. We have about one hundred and fifty-four national



Distribution of forests.

forests, containing approximately one hundred and fifty million acres of land. Of this amount there are about one hundred and forty-five million acres in the United States proper and about five million acres more in Alaska and Porto Rico. At the start there was a great deal of opposition to the establishment of the national forests, because it was claimed that the establishment of a forest at once locked up all the resources of the region, checked industry, prohibited settlements, and made future growth impossible; but precautions are being taken to avoid all of these objections. All agricultural lands are excluded from the boundaries and are left open to settlement. Prospecting and mining are absolutely unchecked. A certain portion of the timber may be cut and sold each year under the direction of the local officers, the

supervisors and rangers. There is seldom any need to refer matters to the Forester or the Secretary of Agriculture at Washington, D.C. The supervisor has direct charge of the national forest and practically all the business connected with it. Supervisors receive a salary varying from \$1500 to \$3000 per year and traveling expenses. The office of the supervisor is usually at some town or central point convenient to the users of the national forest. The rangers are the field men, and they live in the forests and often at places remote from all settlements. They are required to be familiar with lumbering and sawmill business, the handling of live stock, mining, and land laws. They receive from \$900 to \$1500 per year and the use of cabins built by the government. They are required to furnish feed



Forest in New England.

for their own horses and to meet their own traveling expenses. The duties of the guards are similar to those of the rangers, who have supervision over them. The guards are usually temporary men, who are kept on duty during the summer only, to assist in fire patrol and construction work. Their salaries range from \$720 to \$900 a year. The appointment to the position of ranger or supervisor is made only through the Civil Service examina-

tions, and is restricted to applicants between the ages of twenty-one and forty who live in the State where the forest is located.

Forest Enemies.— Aside from the business management of the forests it is the duty of the supervisors, rangers, and guards to protect the forests from various enemies. Many trees fall victims to fungus pests and prompt action is always necessary to eradicate them. Windstorms often destroy many large areas



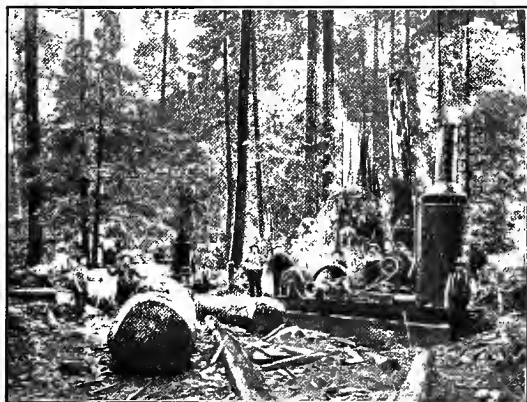
Forest in the tropics.

of forests, but the damage can be offset if new trees are set out immediately. Ants and borers work around the bases or trunks of the trees, and the larvæ of sawflies and moths prey upon the foliage of the trees and frequently cause them to die. Sheep, goats, hogs, cattle, and burros often do a great deal of injury when the range is pastured too closely, and it is the duty of the rangers and supervisors to protect the national forest against

damage from this source. The supervisor allots the range among the various applicants, giving a preference to the small near-by owner and the men who have always used the range.

Another great enemy of the forests is fire. Sometimes the fire may be started from a camp fire which was not thoroughly extinguished, sometimes by a spark from the locomotive of a passing train, sometimes by a careless smoker who may throw a lighted cigar among the dry leaves, and sometimes by hunters and thoughtless young persons, who start a fire and leave it burning without thinking of the consequences. All such offenders are subject to arrest, and severe penalties are inflicted.

Uses of Forests. — National forests are first of all for the benefit of the home builder, and their resources are protected and used for his special welfare. They protect the trees and grow wood for use. Hundreds of millions of feet of timber are sold from the national forests every year, but the cuttings are made so carefully that the stand of trees is left in condition for successive crops. One good use of the national forests is to save every drop of water and make it available for use. They conserve the moisture resulting from snow and rain and keep it from being wasted. On a barren, hard surface the water from many storms rushes down the



Lumbering, Washington.

slopes, washing away the soil, causing sudden floods and untold damage; while on a porous, spongy surface it runs down slowly and brings about an even flow of water throughout most of the year.

In irrigation farming, it is very necessary to have an even flow of water throughout the year, especially during the growing season. The forest cover, with its network of roots, fallen leaves, and branches, prevents the soil being washed away by heavy rains. The foliage of the forest in a measure breaks the force of the rainfall in heavy downpours, and thus lightens the effects of erosion and allows the water to seep into the soil. Another benefit from the national forests is that they provide range for live stock

in many places. Forests are also of great value in any region, as they break the force of the prevailing winds.

Aside from commercial uses, national forests are of great value as places of recreation, for campers, hunters, fishermen, and health or pleasure seekers. They are, in a certain sense, the great open-air playgrounds of the nation, where all may come in contact with nature and enjoy its beauties.

National forests also serve as vast game preserves, in which many species of game are protected that in a short time would become extinct because of the slaughter inflicted upon them by hunters. The buffalo, or American bison, would long ago have become extinct but for the protection afforded him in some of our national parks.

Reforestation and Tree Planting. — In the open prairies and regions where the forests have disappeared steps should be taken to set out trees and to start forests. This has been done on a large scale in Europe, and there is no good reason why the same thing cannot be done in this country. Palestine and Mesopotamia, once very fertile and productive countries, are now almost barren because of the destruction of the forests. Trees modify the climate to a certain extent, and their removal in the countries mentioned is in part responsible for the barren condition that now exists there. The same is true in other countries.

Trees should be set out along the public highways, along the boundaries of farms, along small water courses, and wherever their presence does not prove detrimental in any way. Every pasture should contain at least a few trees to make shade for stock during the warm season of the year. It would also be well to set in trees all waste and broken areas of the farm that cannot be cultivated to advantage. Every farmer should grow enough trees to keep him supplied with fence posts, and other small timbers as they are needed. The kind of tree to be planted will depend on the locality and climate. Suggestions can always be had from the Director of the State Experiment Station in each State, or from the United States Department of Agriculture, at Washington, D.C. In some of the Western States the eucalyptus and the catalpa have been grown successfully and have been especially valuable for fence posts.

A great deal of interest is now being awakened in tree planting through the observance of Arbor Day, which is recognized and observed in nearly every State. It was originated, in 1872, by Hon. J. Sterling Morton, who subsequently became Secretary of Agriculture. The mere planting of trees is not sufficient. They must receive constant care. The weeds must be kept down and the ground around them cultivated. The trees while young must be protected against animals that browse on their foliage or gnaw the bark on the trunks. Every farmer should be far-sighted enough to plant and cultivate a certain number of trees every year, and road overseers should be required to have trees set out along all the public highways. Railroads can also assist in this work by setting out trees along their right of way.

QUESTIONS

1. Discuss the destruction of forests.
2. When was the first national forest established?
3. How are the forest reserves managed?
4. Discuss forest enemies.
5. What are the uses of national forests?
6. What provisions have been made for game preserves?
7. Discuss the necessity of reforestation where forests have been destroyed.
8. Should trees be planted along the highways?
9. How many trees on the public highways near the school have been injured by animals? How many trees are protected against such injury?
10. Visit the nearest wood lot and see whether there has been any damage by fire; what the danger is from fire; whether cattle have destroyed the undergrowth; where trees should be planted; whether the wood lot gets any intelligent care. Write an essay on your wood lot.

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- Report of the Forester*, United States Department of Agriculture, Washington, D.C.
A Primer of Forestry, Farmers' Bulletin No. 173.
Clearing New Land, Farmers' Bulletin No. 150.
Tree Planting in Rural School Grounds, Farmers' Bulletin No. 134.

XXXIX. ROADS AND ROAD BUILDING

It has been said that the roads of a nation are an index to its civilization and progress. The early Romans gave a great deal of attention to road building, and much of their success must be attributed to this fact. Among their achievements along this line may be mentioned the Great Appian Way, leading from Rome to Capua. This was built of square stones, laid on a foundation of sand and mortar, and was one of the great military roads of that time. It was so well constructed that, although it was built 312 B.C., remains of it still may be seen. When the Romans invaded Britain they built roads from place to place as they advanced, and ruins of many of these early highways still remain.

Good roads do much to relieve the monotony of country life, because they make it possible for the farmer to visit the churches, the schools, the post office, and his neighbors without difficulty. Bad roads increase the labor and expense of getting the crops to market. In fact, perishable products may go entirely to waste before they can be taken to market during wet seasons when the roads which have had no attention become muddy and impassable. In the winter time the mud in the roads freezes up and makes the roads so rough that traveling on them is dangerous and difficult. Good roads enable us to haul larger loads and with much less wear and tear on our horses and conveyances.

In the construction and improvement of roads there are four factors to be considered: (1) location, (2) drainage, (3) foundation, (4) surface.

Location. — A most important question in road building is that of location, and yet in many cases it is given but little consideration, so far as the value of the road is concerned. The road is usually located where the least expenditure of money and labor will be required. This means that the road will follow the boundaries of the farm, regardless of the hills and all other obstacles. Such a policy, in a rough and broken country, is far from being

satisfactory and is certainly discouraging to teamsters who have heavy loads to haul to market. As a rule on dirt roads the grade should not exceed 7 per cent, or a rise of seven feet in every hundred feet of the distance traversed. New Jersey and Connecticut excel all other States in the matter of the improvement of their roads, and their extensive experience in this work is of inestimable value to States just beginning any public improvement of this kind. In New Jersey the grade ranges from 5 to 7 per cent, while in Connecticut the general standard grade, for State roads, is 5 per cent. It is estimated that an average horse can pull 1000 pounds on a level, or a zero grade, 900 pounds on a 1 per cent grade, 810 pounds on a 2 per cent grade, 540 pounds on a 4 per cent grade, and so forth.

In level country, roads may be made to follow the boundaries of the farm without inconvenience provided the farms are not too large. A good arrangement is where there is a road around every section and quarter section. By this arrangement no one would have to travel more than half a mile to reach the junction of the road he is traveling with the nearest cross road.

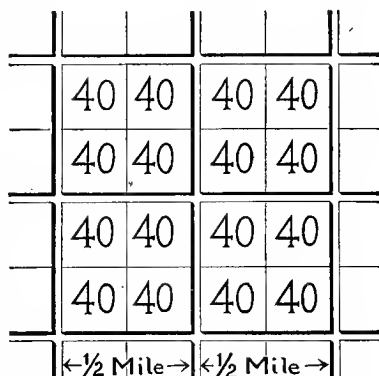


Diagram showing roads around each quarter section.

Drainage. — Good drainage in many places is of more importance than location. A great deal of money is wasted every year in trying to construct roads without proper drainage. Any method of improving a road by placing upon its surface materials of different kinds, without providing for proper drainage, must of necessity fail. In providing for surface drainage, open ditches on both sides of the road should be made, but in many cases a single ditch, on the lower side of the road, will meet all requirements. Different soils and conditions call for different kinds of ditches, but in no case should they be of extreme depth and width.

Furthermore, these deep ditches are frequently washed out to still greater depths by the rains, and become a source of great danger, especially when teams become frightened and draw wagons or vehicles too near the edge of the road.

The best results will generally be secured by having a small ditch, and carrying the water at frequent intervals to the natural water courses on either side by cross drains. For the cross drains and culverts, vitrified tile, iron pipe, or concrete drains may be used. On common country roads, the roadbed is often heaped up high in the center with scrapers and then left to be beaten down by travel, but this is a serious mistake, which should be avoided whenever possible. The roadbed can be shaped much better with a road grader, which gives a very gradual slope from the center to either side. Generally a rise of eight to ten inches in the center will be sufficient to afford ample drainage. Road graders are costly, and in some cases the road once graded can be kept in excellent shape by using a plank or split-log drag. Usually a road district corresponds with the school district, and the road overseer has supervision over all the roads of the district. The building of costly bridges over large streams is left to the county commissioners, who draw on the county funds for this purpose.

Foundation. — In road building, or any other piece of construction in the line of engineering, the first requisite is a proper foundation. In paved streets and roads, many people suppose that the load is borne by the surface of the paving, but such is not the case. The load is really supported by the foundation, on which the surface construction rests. The paving merely serves as a roof to keep the foundation dry and to protect it against indentation and wear when heavy wagons and vehicles of various kinds are driven over the road. If excavations are made for drainage pipes or sewers, the ground must be well firmed and packed before any paving is placed on the road or street. If this is not done, the soil will settle after heavy rains, and the paving, being left without any support, will cave in. In this work the use of a heavy steam roller is necessary to give proper firmness to the ground over which the roadbed passes. In the country the clay soil usually affords a proper foundation when properly graded and

packed; but in cities, for street work, various materials are used in building up a foundation.

Coal cinders and screenings from coke are usually very satisfactory for this purpose. Waste products from factories are available in many localities and may be used to good advantage. The waste material from fire-clay brick, sewer pipe, broken and unused pieces of shells from button factories are frequently used and are found very satisfactory for foundation work. In regions where there are large smelters slag is used for the same purpose.

In cities, after the ground has been leveled and rolled, a foundation of gravel and concrete is often provided before the paving is put down, but on country roads this is too expensive.

The surface should have sufficient slope to cause all rain water to drain off easily and quickly. The lateral slope from the center to either side should be about one in twelve. Some road builders have a continuous curve for the surface; others have a curve at the center, while the sides have an even slope. When we speak of the lateral slope as being one in twelve, we mean that there is a slope downward of one inch to the foot. On this scale a street twenty-four feet wide would be one foot higher at the center of the crown of the road than at either side. In many instances the center of the crown is only from five to eight inches higher than each side of the street.

The width of the surface should be great enough to accommodate all traffic, so that vehicles of all kinds may have sufficient room to pass each other without difficulty. Wherever possible, bridges should be practically of the same width as the road.

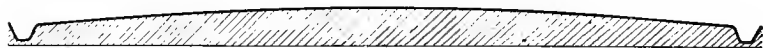
In this country the universal custom is for each driver to turn to his right in passing any vehicle which he may meet in his road, but this custom varies in different countries. In many parts of Canada drivers of vehicles turn to the left instead of the right. Custom demands that heavily loaded wagons be given the right of way, and that empty wagons or light-going vehicles turn either to the right or left, as the situation may demand.

Wherever deep fills are made in the roadbed, the surface should

be protected from washing, by flanking the sides with a wall of heavy stone and gravel. If this is not done, every heavy rain will wash away the soil and undermine the surface of the roadbed. When stone cannot be had, piles should be driven into the ground, along the sides of the embankment, and heavy planks two inches thick should then be placed between the piles and the embankment so that the soil cannot be washed away by the rains.

Kinds of Roads. — There are many kinds of roads in use in various parts of the country, but for general purposes they may be classed as follows: (1) common dirt roads; (2) sand-clay roads; (3) shell-rock roads, (4) plank roads; (5) macadam roads; (6) telford roads; (7) brick-paved roads; (8) cobblestone roads; (9) block-paved roads; (10) asphalt roads; (11) oiled roads.

Common Dirt Roads. — In these roads the natural surface of the ground forms the roadbed. No special improvement is given



Section of a dirt road.

it except to provide proper drainage and grading. Whenever possible the roadbed should be worked with a road grader and firmed with a heavy roller.

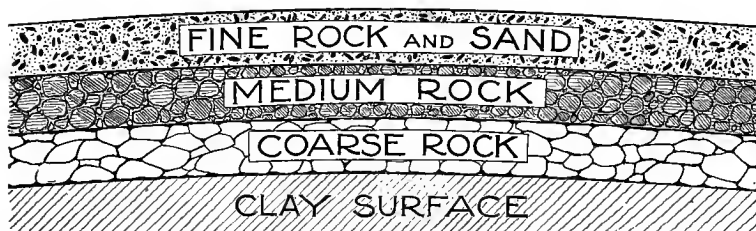
After each rain or thaw the roadbed should be carefully gone over with a split-log drag, which will draw the dirt towards the center of the road and will fill up all ruts and depressions.

Sand-clay Roads. — In many parts of Florida and the South the roadbeds are made bad on account of the deep sand beds. This is remedied by hauling clay and mixing it with the upper six or seven inches of sand. The clay and sand are mixed while wet and are thoroughly incorporated with each other by the use of harrows and diskers. Then the surface is carefully rounded and rolled, and the work is finished.

Shell-rock Roads. — In some parts of Florida, and especially in the vicinity of St. Augustine, there are large deposits of coquina, or shell rock, which when crushed can be used to good advantage for surfacing roadbeds. There is a very good shell-rock road extending from Jacksonville, Florida, to St. Augustine, Florida.

Plank Roads. — Some years ago a number of plank roads were built in Missouri and other States, but they were found objectionable, and their construction has been discontinued. It was found that the planks were slippery and dangerous during wet weather and in the winter time when there was snow or ice on the surface of the road. The cost of constructing such roads was so great that but few communities undertook the experiment.

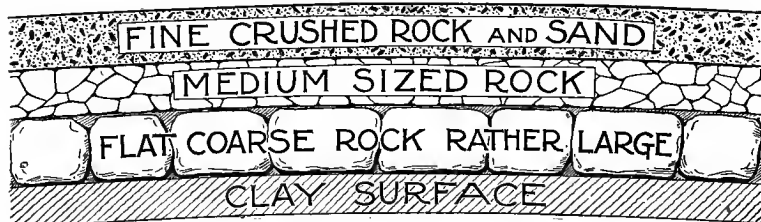
Macadam Roads. — These roads are the outgrowth of the ideas of John L. Macadam, a Scotchman, who lived from 1756 to 1836 and gave considerable attention to the matter of road building. After the ground has been properly graded and prepared, there is placed, first a layer of small stone, two or three inches in diameter,



Section of a macadam road.

which is firmly packed or rolled; then another layer of stone, about half the size of the stones of the first layer, is added, rolled, and packed. This layer is then crowned with a layer of finely crushed rock and sand, and is likewise rolled and packed. A great many of these roads are found in Missouri, Tennessee, and Kentucky, and in some of the Eastern States. In Missouri they are frequently called gravel roads, while in Tennessee and Kentucky they are designated as pikes or turnpikes. Generally the county furnishes half of the funds needed to build the road, and the property owners along its route subscribe the remainder. In order to keep up the road, a toll of two or three cents a mile is generally charged, which is collected by the tollgate keeper at either end of the road.

Telford Roads. — The telford road, like the macadam road, is a Scotch product. It differs from the macadam road in having its first layer of large flat stones laid in regular order.



Section of a telford road.

Brick-paved Roads. — In some localities, where brick of good quality are manufactured under favorable conditions as to cost and accessibility, they may be used to good purpose in constructing roads and streets. The usual method is to grade and to prepare the surface in the same way as for a dirt road. The soil must be thoroughly compacted with the steam roller and leveler, so that there will be no settling of the roadbed afterwards. A little sand is scattered over the surface first, and then a course of brick is laid down flatwise, and this is followed with more sand and another course of brick laid down lengthwise. In some cases, sand is again used to fill the crevices among the brick, in the top layer; and in other cases, melted pitch is used. The latter material is the most satisfactory for fillings, as it is impervious to water and binds and holds the brick together. In cities the gutters or side ditches are built up of concrete; but in building country roads, cobblestones are sometimes used for this purpose. After the top course of brick is laid, the roadbed should be carefully rolled with the steam roller, until the surface is even and free from inequalities.

Cobblestone Roads. — Heavy cobblestones of considerable size are often used for paving on streets and highways where there is much heavy hauling. In this arrangement the construction is similar to that for brick paving, except that square blocks of stone, about the size of three or four bricks, are used for the paving material.

Block-paved Roads. — In block-paved roads the construction is similar to that for brick paving, except that square blocks of wood are used instead of brick. Bois d'Arc and walnut make the most durable material.

Asphalt Roads. — For boulevards and for residence streets asphalt paving is very popular. The surface is carefully graded, rolled, and compacted; and then a layer of concrete several inches



A street in Paris.

in thickness is placed on the roadbed; and when this has become thoroughly dry and hard, a heavy layer of pitch-covered pebbles is spread and then a smooth coating of asphalt mixed with fine sand is put on. On both sides of the roadbed the asphalt surface is flanked with gutters and curbstones built up of concrete.

Oiled Roads. — In Southern California roads are often improved by treating them with oil. After the roadbed has been graded, it is plowed up and harrowed. It is then sprinkled with black crude oil. The soil is thoroughly incorporated with the oil by harrowing and by disking. After the oil has soaked into the ground thoroughly, the roadbed is rolled and leveled, and is then

ready for use. The streets of Santa Barbara, California, which have been treated in this way with oil, have proved very satisfactory.

A few of the railroad companies have used crude oil at times for sprinkling their roadbeds through dry, sandy sections of the deserts to lay the dust. In southern Oklahoma it is frequently used on race tracks for the same purpose.

The Management and Construction of Country Roads. — In recent years Georgia has made great strides in the management and construction of country roads. Some of their most noticeable features are their width, and the gutters and curbings which line them. In Fulton County every one of the county roads now being constructed is of macadam, and has its brick gutter and stone curbing, just as the city street pavement has. On one side of the road there is also a dirt sidewalk as one of the most important features of the road. They provide perfect drainage, sewers being placed at intervals to carry off the storm water to places where it will do no harm. The open ditch at the side of the road is eliminated, and the danger of the road's caving or being undermined at the sides is removed.

Fulton County has not accomplished all these results in a day nor in a year, but the greater part of the permanent work has been done during the past ten years.

One and One-half Million Dollars spent on Roads. — The books of the county commissioners show that \$1,507,000 has been spent by the county on the country roads in the last ten years alone, and several hundred thousands of dollars were spent in the preceding decade.

The county does not levy a special road tax for general purposes, and all money spent on the roads is appropriated by the commissioners out of the general county fund. In 1899 the commissioners appropriated \$97,000 for road work. The following year \$101,000 was set aside for that purpose, and the appropriation has been increased by from \$10,000 to \$20,000 every year with two or three exceptions. In 1907 the appropriation was \$203,000, and in 1908 it was \$201,000.

The total county tax levy for all purposes is six mills, or sixty cents on every hundred dollars' worth of property. This brings

in an annual revenue of about one-half million dollars, and during the past two years almost half of the total revenue has been spent on the roads.

There is a special road tax of \$2.50, or five days' work upon the highways, which is levied upon every male citizen of voting age in the county. This money is spent in the districts where it is paid and is expended for repair work only on roads which have not yet been macadamized by the county.

The money appropriated from the general fund is spent in any part of the county, at the discretion of the commissioners. The county has not issued any road bonds, paying the entire cost out of the regular annual taxes.

The plan used in Fulton County, Georgia, is worthy of study and imitation in other localities, and we hope the day is not far distant when we may see a perfect system of road building inaugurated by every State in the Union. You can start the work in your locality by writing to your State Experiment Station and to the Superintendent of Public Documents at Washington, D.C., for bulletins on road building. Two bulletins you should have are *Roadmaking*, by George B. Ellis, of Columbia, Missouri, and Bulletin No. 2 of the Highway Department of the State of Ohio, entitled *The Construction of County Roads*, by Sam Huston. Read these and other bulletins and then call meetings at your schoolhouse and try to get your citizens interested in good roads.

EXERCISES

1. Let the pupils examine the roads in the neighborhood and report on the following points: (a) drainage, (b) grade, (c) location.
2. Let each pupil suggest improvements in methods for grading and draining roads.
3. Examine culverts and bridges, and note all defects. Suggest remedies.
4. Study the road laws of different States and suggest improvements needed in your own State laws.

QUESTIONS

1. Are roads an index to the civilization of a country? Why?
2. Discuss early Roman attempts at road building.
3. What four things must be considered in road building?

4. Discuss (a) location, (b) drainage.
5. Discuss (a) foundation, (b) surface.
6. Name the kinds of roads.
7. Discuss (a) common dirt roads, (b) sand-clay roads.
8. Describe (a) plank roads, (b) macadam roads.
9. Discuss (a) telford roads, (b) cobblestone roads, (c) block-paved streets.
10. Discuss (a) brick paving and (b) asphalt paving.
11. Describe oiled roads.
12. Describe the plan of road improvement followed (a) in your locality, (b) in Georgia.

REFERENCES

- Macadam Roads*, Farmers' Bulletin No. 338. *Sand-clay and Burnt-clay Roads*, Farmers' Bulletin No. 311.

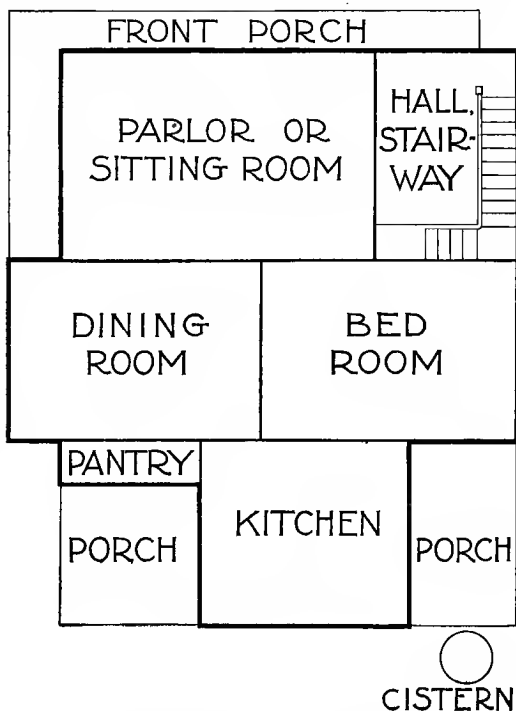
XL. FARM IMPROVEMENTS

UNDER the head of farm improvements may be included the country home or house, and its surroundings, the barn, fences, gates, and other things of this nature.

The House. — In building a house, our first concern is generally to secure a suitable location. If possible a piece of ground should be selected in which the surface slopes downward from the house in every direction, so that the drainage will be as nearly perfect as possible. The site should be reasonably close to the road, and when possible it will be found best to have the house face south and east. The cellar should be well drained, should be well supplied with windows, and should be kept thoroughly aired and ventilated.

The cost of the house and the kind of materials used

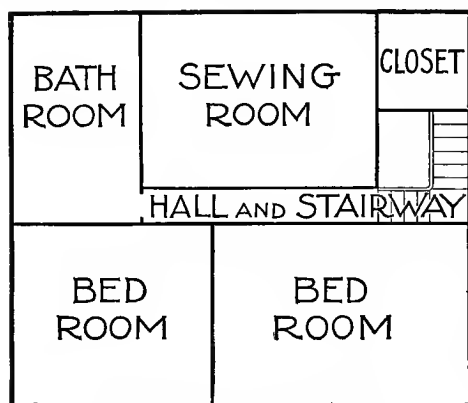
will vary with the taste of the individual and the amount of money that can be expended. A good arrangement is found in the two-



First-floor plan of a two-story house.

story house having a kitchen, pantry, dining room, and parlor or reception room on the first floor. The sitting room, sleeping rooms, bath room, and closets are frequently placed on the second floor. Generally it will be found more convenient to have the sitting room on the first floor adjoining the dining room.

The teacher should have the students study and criticise the plan given here, and then let them submit house plans of their own designing. It will also be an interesting exercise for each



Second floor plan of a two-story house.

student to submit a plan of his own home with an estimate of the cost of construction.

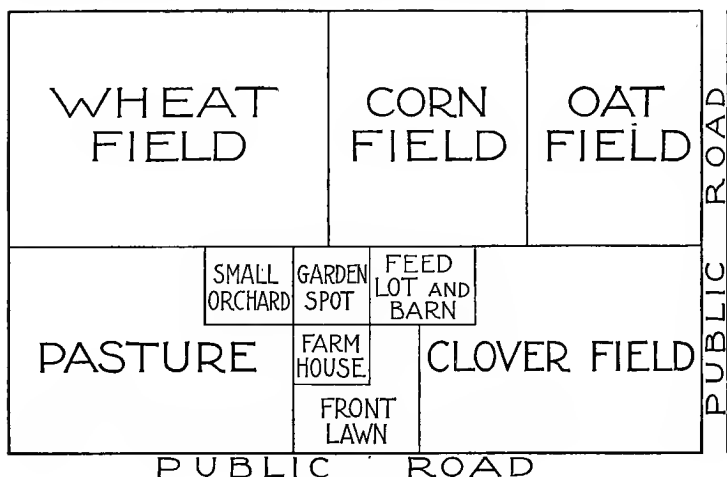
The House Surroundings. — Plenty of shade trees should be provided, but they should be so grouped that they will not interfere with the view in front of the house, nor should they shut out the air and sunlight on either side of the house. A few

rose bushes and flowers may be judiciously placed here and there, but they should not be placed in front where they would obstruct or mar the view. Along the sides of the house chrysanthemums may be used to screen the foundation with good effect, while the crimson rambler or the Virginia creeper may be trained along the sides of the veranda to protect it from the hot sun in the summer time.

The Farm Plan. — The general plan or arrangement of the farm will vary with the tastes of the individual and the means at his disposal, but whatever the arrangement may be the barn and out-buildings should be in the rear and out of view as much as possible. In some cases the barn is the largest and most important building on the farm instead of being in keeping with the farm residence. Let there be nothing to suggest that the farmer thinks more of the welfare of his stock than of the welfare of his family.

The general arrangement of the yard, lawn, barn lot, feed lot, poultry yard, orchard, varies greatly; but any arrangement in which the farm residence and lawn are not made prominent may be regarded as faulty.

The students should study and criticise the plan given here and then submit plans of their own designing for a model farm of one hundred and sixty acres or more of land.

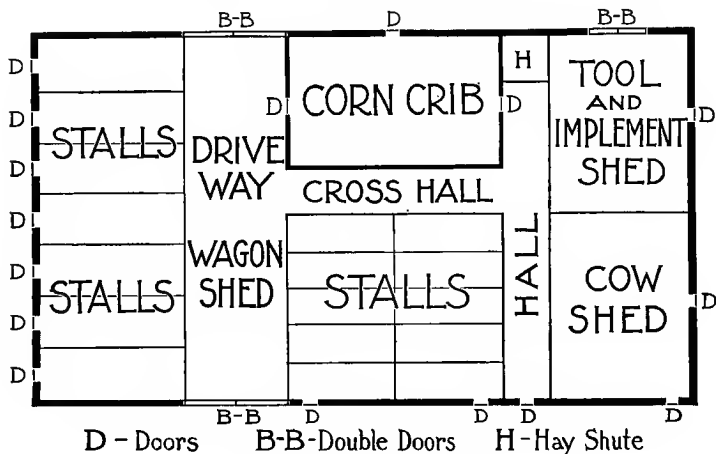


Plan of a farm.

The Barn. — Nearly every farmer has his own ideas about how the barn shall be arranged, and any plan which will afford shed room for the stock, grain, hay, vehicles, and farm implements may be regarded as satisfactory. Everything should be made as convenient as possible, and the grain bins and cribs should be arranged so that they will be near the stalls where the stock is to be fed. We submit here the plan of a barn owned by a prosperous Missouri farmer which seems fairly satisfactory. This barn is a two-story structure, having on the ground floor a row of stalls for horses at the left, then a large driveway and shed room for buggies and wagons. In the center there is a large crib at the rear and two rows of stalls in front. Adjoining these is a small hallway, and to the right of it there are an implement shed and a

cow shed. The upper part of the barn contains the grain bins and the hay loft.

The barn should be provided with a suitable number of windows for light and ventilation, and the stalls for the horses should be separated from each other by double walls. Each stall should be provided with trough and hay rack convenient to the hall or . . .



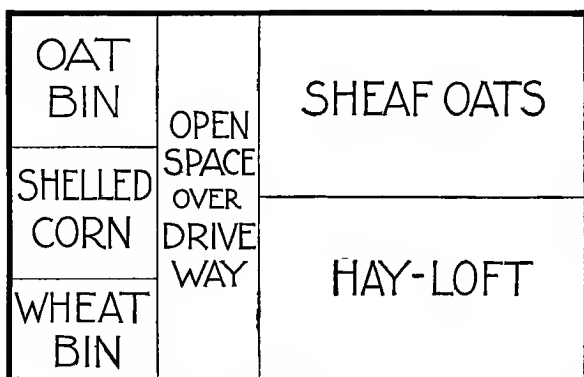
First floor plan of a barn.

passageway, so that the feeding may be done without having to pass through the stalls. Each morning the stalls should be cleaned thoroughly.

If possible, the outside of the barn and the roof should be painted in order to protect both from decay. The saving thus accomplished will more than pay for the painting in every case. The size of the barn will depend upon the means of the farmer and the amount of stock and machinery to be sheltered. The farmer in every case should make provisions to place all of his machinery under cover. The practice some farmers have of leaving self binders, mowing machines, plows, corn planters, and other implements out in the weather during the whole year is a ruinous policy. The waste occasioned in this way in every case would more than pay for the building of a shed room for storing the machinery. The same is true in regard to providing proper shelter

for stock. The loss to farmers through disease and death of stock exposed to raw weather in severe climates is considerable and could be avoided by providing windbreaks and good shed rooms.

Fences. — The kind of fencing used by the farmer will depend largely on his natural surroundings. In wooded sections, where there is plenty of timber, rail fences and plank fences abound. In many cases the farmer may have a forest close at hand where he and his helpers may split and make all the rails needed at a small outlay. When this is the case, the outside fences and cross fences are frequently of rails, while the lawn will be inclosed with a



Second floor plan of a barn.

plank fence. The front yard will often look more inviting without any fence. The poultry yard should be surrounded with a high paling fence or a regular poultry wire fence.

When the fence rails dry out and get somewhat old, farmers frequently utilize them in building what is known as the Ferguson fence. In this arrangement posts are set in the ground and the fence rails are attached to the posts by means of fencing wire and staples.

This is usually a very economical fence, not only from the standpoint of materials, but also on account of the saving of space in the fence row. The teacher will find it a very interesting and instructive exercise to have the pupils calculate the amount of waste

space in a forty-acre field inclosed with a common zigzag rail fence that can be saved by means of a Ferguson fence. Have them estimate also the value of this ground if planted in corn or the staple crop of the neighborhood.

For posts, white oak, black locust, and catalpa trees are generally used. Whenever possible, the bottom ends of the posts should be dipped in coal tar or pitch, as this protects them against decay.

In prairie countries wire fences are the most economical and for that reason are in general use. For fencing up cattle the common barbed wire is preferred, while for hogs or poultry various forms of woven wire fences are used. Where timber is hard to obtain, concrete or metal posts have been tried and found satisfactory. For lawns and yards, close-woven wire fences and iron pickets produce a good effect, but are somewhat expensive.

In mountainous sections stone fences are often built up from the loose stone gathered on the fields and prove very durable and satisfactory.

Some years ago there was a great deal of enthusiasm over the so-called live fences or hedges. There are a number of plants that are serviceable for this purpose, but the Osage orange stands at the head of the list for many sections. When kept properly trimmed, it makes a very effective fence against marauding people as well as against stock. Other plants that are sometimes utilized for hedges are the buckthorn, hawthorn, and the honey locust. The chief objection to live fences is that the plants are frequently allowed to grow too large, and the extensive network of roots on both sides of the fence saps the life and nourishment of the soil to such an extent that no kind of cultivated plant can be grown within twenty or thirty feet of the fence. Besides, the high-grown hedge shuts out the free circulation of the air in the field and makes plowing oppressive to the team as well as to the workman. Since 1885 the enthusiasm for live fences on farms has been on the wane, and they are now becoming very scarce, so far as their use for general farming purposes is concerned.

Since 1870 many States have passed stock laws requiring every man to fence in his own stock instead of fencing out those belonging to his neighbors. The result has been a great saving to farm-

ers in every case. The operation of the stock law saved the farmers \$150,000,000 in New York, and \$90,000,000 in Missouri.

About the only use remaining for hedges is for windbreaks and for ornamental purposes on lawns and parks.

Gates. — No farm is complete that is not properly supplied with gates that lead from one field to another and that can be opened without dismounting when traveling on horseback. The front gate leading from the public road to the lawn should be so arranged that it can be opened by a mechanism of levers, ropes, and pulleys without the driver's getting out of his wagon or buggy.

Such gates can be ordered from the factory through the local hardware dealer, but if the farmer has a mechanical turn, he can easily make such a gate himself. If the gate is to be made of wood, it will be found best to get some light material like white pine, so that the weight of the gate will not pull off the hinges or cause the gatepost to lean out of position. The gateposts should be of white oak or cedar and must be at least a foot square at the top and considerably larger at the bottom. The post to which the gate is attached by its hinges should be set three or four feet in the ground and firmly anchored.

Farm mechanics treats of the making of the necessary farm conveniences; the building of walks, driveways, and small bridges; the construction of cisterns, water tanks, compression tanks, and water troughs; the digging of ponds and lakes; constructing silos, ice houses, and other outbuildings; the setting up, care, and management of machinery; blacksmithing; the management of steam and gasoline engines; the management of stoves and furnaces; farm drainage; and other kindred subjects. Boys will find that their work in manual training will be of inestimable value to them in after life on the farm. Often a whole day's work is lost on the farm because some simple pieces of ironwork in the machinery used has been broken or lost. In many such cases the young man who has had a course of ironwork in his manual training exercises could repair the breakage in a few minutes and but little time would be lost. The same young man could easily construct an ice box, make a clothes rack, a self-adjusting clothes line for the laundress, and many other necessary conveniences. His knowledge of blacksmithing would enable him to sharpen the

plowshares and the sections of the sickle blade for the mowing machine or the self binder, so that no time would be lost in the harvest field while such repairs were being made. The farmer who would be successful must be a farm mechanic. Those who cling to old ideas will soon be relegated to the rear.

QUESTIONS

1. Discuss the location and construction of a farmhouse.
2. Make a drawing or plan of your own home.
3. Discuss the house surroundings.
4. Discuss the farm plan.
5. Submit a diagram showing location of fields, lawn, and barnyard on your father's farm.
6. Discuss the plans for a farm barn.
7. Should the barn have windows? Why?
8. Discuss fencing and fences.
9. Discuss gates and their arrangement.
10. Discuss farm mechanics in a general way.

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XLI. FUEL AND LIGHT

THE expense of fuel and light in many parts of our country constitutes a considerable item to the farmer, and some attention should be given it in our study of agriculture.

Fuel. — Any substance used for making fire is known as fuel. It is generally a form of carbon or some compound of carbon. Fuels may be divided as follows: (1) vegetable fuels, wood, methyl and ethyl alcohol, charcoal, etc.; (2) mineral fuels, peat, lignite, cannel coal, bituminous coal, anthracite, etc.; (3) mineral oils and gases, naphtha, gasoline, benzine, kerosene, and natural gas.

Wood. — In timbered countries the common fuel is wood, because of its cheapness. In prairie countries, when it is a long way to the timber supply, the use of wood is expensive. If a quick hot fire is desired, some of the soft woods, like pine, spruce, fir, hemlock, cedar, or redwood, will be found serviceable. If a slow steady fire is preferred, some of the hard woods, like oak, hickory, ash, beech, maple, birch, and walnut, will be found desirable.

Charcoal. — Sometimes cordwood is piled up in heaps and after it has been covered with soil, a slow fire is started underneath the whole mass. This drives off the volatile gases, chars the wood, and produces charcoal. Charcoal is used to produce heat for warming irons and for broiling purposes.

Peat is a substance of vegetable origin, partially decayed, forming a kind of turf or bog. It is found in lowlands or swamps, in cool, temperate climates. Large quantities of it are found in Ireland and in Alaska. When desired for use, the peat is cut into thin oblong blocks and dried in the sun. It makes a fairly good fuel.

Lignite is of a brownish hue and is a formation between peat and true coal, in which the woody structure is retained. It is soft and crumbly. Lignite is mined in Colorado, Montana, Wyoming, Oklahoma, and the Dakotas.

Bituminous coal is soft coal much of which burns freely, giving off volumes of pitchy smoke. It is found in the eastern and western parts of the United States, and also in Missouri, Arkansas, Ohio, Indiana, Illinois, Kansas, and Oklahoma.

Cannel coal is a variety of bituminous coal. It is much harder than ordinary bituminous coal and burns with but little smoke. It is found in few localities and largely preferred for blacksmithing.

Anthracite is the hardest and most compact coal known in this country. It is almost free from hydrocarbons or oils and burns with a slight blue flame and with strong heat. On account of its hardness it can be handled without smutting one's hands, and when placed in the stove it burns for a long time. If the stove is filled with anthracite in the morning, usually the supply will last all day without replenishing. Nearly all of the anthracite used in the United States is mined in the eastern part of Pennsylvania, and on account of its limited area of production it is generally somewhat expensive.

Coke is coal which has been heated in ovens or kilns from which the air has been partially excluded. The heating is continued until all the hydrocarbons have been burned or driven off and a light substance resembling charcoal remains. On account of its lightness and cleanliness it makes a very satisfactory fuel.

Coal gas is a very important fuel in cities and is obtained by distilling coal. It is stored in a large tank and piped from this to the places where it is to be used. This gas is also used for lighting purposes.

Water gas is prepared by passing water in the form of superheated steam over glowing anthracite coal. The resulting gas contains equal volumes of carbon monoxide and free hydrogen. It is enriched by the addition of petroleum vapor and is used for both lighting and heating.

Natural gas is obtained by boring to a considerable depth into the earth and is found in various parts of the United States. Profitable gas wells have been sunk in California, in the Beaumont district in Texas, in Oklahoma, Louisiana, western Pennsylvania, West Virginia, Central Ohio, and some parts of Indiana.

This gas is used for heating, lighting, and cooking, and its use is very satisfactory. On account of its freedom from sulphur

and other injurious impurities natural gas is a good fuel for the smelting of iron or steel. Natural gas is piped from the gas fields to considerable distances. The Oklahoma field supplies Kansas City, and the Indiana gas belt supplies Chicago. The price varies according to the distance the gas is piped and the quantity that is used. In Oklahoma it ranges from five to thirty cents per thousand feet.

Acetylene gas as a fuel thus far has not been satisfactory, but it is used in many places as an illuminant. It may be prepared very cheaply by treating calcium carbide with water. When impure it has an offensive odor and is poisonous when breathed. Like other inflammable gases, it is explosive when mixed with air and must be handled with extreme care. The mixture to be explosive must contain from 3 per cent to 65 per cent of the gas. For safety the generator should be kept in the basement or in a small outbuilding. This will safeguard against accidents in families where there are small children or other careless persons around.

Gasoline gas is generated from gasoline and is used for cooking and for lighting. It is also used to a great extent by plumbers and tinnerns for heating their soldering irons. In cooking ranges two forms of generators are used. In the ordinary range a small portion of gasoline is allowed to run down into a little cup beneath each burner, and then the liquid is shut off by closing the valve and the portion in the cup is ignited. This heats the burner above until it is hot enough to convert the liquid gasoline into gas when the gasoline is turned on again. A lighted match is then applied to the burner, and the gas will burn with a steady blue flame. The gasoline tank on top of the stove should never be filled when the stove is lighted or when there are lighted lamps or fire stoves near. Gasoline vaporizes very easily, and the vapor ignites readily, hence great care must be exercised in its use in order to guard against explosions. Leaky tanks or leaky valves and joints must be repaired promptly or accidents are sure to result.

In some of the higher-priced cooking ranges self-generators are used in which the gasoline vaporizes as it passes through a long tube.

Gasoline makes a very cheap and efficient fuel for cooking purposes on the farm. Its use in the summer time is advisable because of the small amount of heat given off into the room.

Petroleum. — The word *petroleum* means literally rock oil. This name was given it because the oil is obtained by boring into soft layers of oil-bearing rock. Its existence was known for some time, but it was not found in paying quantities until 1859, when Colonel E. L. Drake, of Titusville, Pennsylvania, bored a well in search of an oil which he expected to use as a remedy for rheumatism. Colonel Drake struck oil at a depth of sixty feet, and his well produced him about two thousand gallons the first year. Soon other wells were sunk, and oil in such abundance was found that it became possible to use it for both light and fuel. Since then oil has been found in West Virginia, southern Ohio, Indiana, Colorado, California, Texas, Kansas, Oklahoma, and Louisiana.

Crude petroleum is of a dark brown or black color and has a very disagreeable odor. On being heated the following liquids separate and distill at the temperatures mentioned:

Naphtha	between 40– 70 F.
Gasoline	between 70– 90 F.
Benzine	between 90–150 F.
Kerosene	between 150–280 F.
Lubricating oils	between 280–400 F.

The residue contains vaseline, paraffine, and coal tar. Good kerosene should not flash or take fire till warmed to 150° F. The flashing test varies in different States, and some require that the flashing point shall be as high as 200°. Many of the lower grades of kerosene found on the market have a flashing point of only 135°. A lower test is dangerous. A simple test may be made by taking a teacup one quarter full of cold water in which a thermometer has been placed and adding boiling water till the temperature reaches 110° F. Then add two teaspoonfuls of the kerosene and try to ignite the oil by passing a lighted taper over it. If it ignites, it is not safe. Should it not ignite, other temperatures may be tested in the same way until the exact flashing point is determined.

On account of its cheapness kerosene is the universal illuminant used in the country. The crude oil is used for fuel in locomotives on certain railway lines, on account of its cheapness and on account of its being more cleanly than coal.

Alcohol. — Alcohol is used as a fuel for spirit lamps by dentists and by students in laboratories where gas cannot be obtained. It is also used in heating chafing dishes. Recent experimenters claim that it can also be satisfactorily used for cooking purposes in countries where excessive internal revenue taxes are not levied upon it.

There are two kinds of alcohol that can be used for this purpose, one known as methyl, or wood, alcohol, and a second one called ethyl, or grain, alcohol.

Wood alcohol is obtained by the dry or destructive distillation of wood. It was discovered by Taylor in 1812, and he gave to it the name of wood spirit. Wood alcohol is poisonous and so no restrictions are usually placed upon its sale for fuel. It burns with a pale blue flame and produces a fair amount of heat.

Ethyl alcohol is obtained by distilling fermented liquors, such as wine, the fermented juice of sugar beets, malted corn, barley, rye, and other grain. In England and France ethyl alcohol employed for industrial purposes is exempted from taxation to a large extent when it has been treated with one tenth per cent of wood alcohol, resin, and certain mineral oils. In this state it is known as denatured alcohol, and it cannot be used as a beverage. Provision has been made in the United States for the sale of denatured alcohol at greatly reduced rates. It is believed that the production and use of denatured alcohol will give renewed impetus to the sugar beet industry and make it much more profitable.

Candles. — One of our earliest means of illumination was by means of ordinary candles. They give a weak flickering flame and afford a very poor light, but for a long time there was no available substitute and they were in general use. Candles are made of tallow, wax, or spermaceti.

Electricity. — In cities electricity is found to be a very satisfactory and economical means of illumination. The common incandescent lamp was devised by Thomas Edison in 1879 and is suitable for electric lighting indoors. It consists of an air-tight bulb in which is fitted a carbonized filament in the form of a loop. When a current of electricity is passed through this carbonized filament, it becomes hot and gives off a bright light.

For street lighting what is known as the arc light is used. It

consists of two carbons about the size of a lumberman's lead pencil. When the current of electricity is made to pass from one carbon to the other, a bright light is given off. Another form of electric light is the mercury vapor lamp, which consists of a long glass tube exhausted to a high vacuum. The electric current is carried by the mercury vapor from one terminal to the other and gives off a yellow-greenish light of dazzling brilliancy.

Electricity is used for heating in the electric furnace, for cooking, and for heating laundry irons. It is serviceable in cities, but not economical in the country except near large electric power plants.

EXERCISES

1. Visit the coal dealer and ascertain the price of coal per ton and compare this with the cost of wood in your locality.
2. Compare the cost and efficiency of soft coal and hard coal.
3. Compare the cost of soft coal and natural gas for fuel, when the gas can be had at the rate of twenty-five to thirty cents per thousand, for two stoves, and sixteen thousand feet of natural gas are used during the month.
4. Compare the cost of coal and gasoline for a cooking range.
5. Compare the cost of lighting four rooms for three hours per day for a month by kerosene, gas, and electricity when all three may be had.

QUESTIONS

1. Define fuel.
2. Name the general classes of fuels.
3. Discuss (a) wood, (b) charcoal.
4. Describe (a) peat, (b) lignite.
5. Discuss (a) bituminous coal, (b) cannel coal, (c) anthracite, (d) coke.
6. Describe (a) water gas, (b) coal gas.
7. Discuss natural gas.
8. Discuss (a) acetylene, (b) gasoline.
9. Give the history of the discovery of petroleum.
10. Describe petroleum.
11. Name some of its distilled products.
12. Discuss alcohol as a fuel.
13. Discuss (a) candles, (b) electricity.

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XLII. STOCK FEEDING

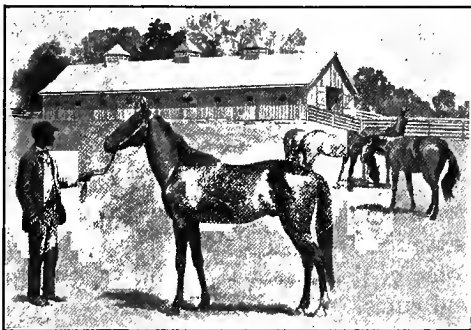
Objects of Feeding. — The objects of feeding are: (1) to repair the waste of the system and maintain life; (2) to supply heat; (3) to furnish force and energy; (4) to provide the materials needed to insure increase of flesh by growth or fattening; (5) to make special products, such as milk, eggs, feathers, wool, etc.

Kinds of Food. — We usually classify food for stock as forage or roughage and concentrates. Under the first we include cornstalks, hay, straw, silage, tubers, roots, and all other foods which contain a large amount of crude fiber or water in proportion to the nutritive elements; while the concentrates are generally the seeds of plants and their products which contain a minimum amount of crude fiber and water.

In a more specific way we may group the kinds of food for stock

as follows: (1) albuminoids or proteids, (2) the fats, (3) the carbohydrates, (4) mineral matter.

Albuminoid or Proteid Feeds. — Food substances like the white of egg, the gluten of wheat, and the fibrin of meat, containing nitrogen, we call albuminoids or proteids. These foods containing nitrogen furnish the necessary elements for making muscle, bone, horn, hair, blood, and milk. Cotton seed, cotton-seed meal, pea-vine hay, cowpeas, soy beans, alfalfa, and all other leguminous plants are rich in proteid. Proteids contain about 16 per cent of nitrogen, so that if we know the amount of nitrogen we can calculate the amount of proteids very easily by multiplying the per-



On a stock farm.

centage found of nitrogen by 6.25. The total amount of proteids thus calculated is called protein.

The fats contain carbon, hydrogen, and oxygen. Fat exists in grains and in the seeds of certain plants like flax and cotton. The percentage of fat in fodder is variously estimated at from 3 to 8 per cent of the material in the dry state. The fats are especially valuable as producers of energy and are capable of producing two and one fourth times as much energy as an equal amount of starch or sugar. The amount of fat content may be determined by dissolving it with ether or other solvents. The resultant quantity is known as crude fat, but after the ether has been evaporated and other impurities have been removed the substance remaining is known as pure fat.

The carbohydrates consist of carbon, hydrogen, and oxygen, but the last two are always found in the same proportion as they are found in water. The carbohydrates produce force and energy and help to keep the body warm. If there is more of this kind of food than is needed, the body stores it up in the form of fat, which may be drawn upon at any time when needed. When the carbohydrates are practically consumed, the body then draws upon the proteids for the food necessary to keep it warm and to furnish the energy required for work. The addition of these foods to those containing proteid always lessens the amount of proteid required. Some of the principal carbohydrates are cellulose, starch, sugars, and gums.

Cellulose is the substance of which the cell walls or the woody part of the plant is mainly composed. It is found in ripe straw, in seeds, and in the stems and husks of plants. Its most familiar form is the paper of commerce. The cellulose incloses the starch grains, and on account of its not being very soluble it protects the starch from being dissolved and washed away from plants by rains.

Starch is the common form of plant food, and it consists of solid grains ranging in size from one three hundredth of an inch to one four thousandth of an inch. Starch enters largely into the composition of grains and of all root and tuber crops. It is readily converted into grape sugar and dextrine when treated with certain acids.

Sugar is the soluble form of carbohydrates which circulates in plants and is immediately available as plant food. When the plant manufactures more food than is needed, the surplus is stored up in the form of starch. When this reserve stock of food is needed, some of it is changed back into sugar by the help of a ferment known as diastase. On account of their solubility the sugars are digested with ease. The principal kinds of sugar are cane sugar, derived from sugar cane, sorghum, and sugar beets, grape sugar from starch, fruit sugar from fruits and honey, malt sugar from malted grain, and milk sugar from cow milk. The amount of sugar in ordinary foodstuffs is small, but large amounts of it are formed from starch and other carbohydrates in the process of digestion.

The gums are not important as food compounds, and only a small amount of them is found in plants used for stock feeding.

Pentose. — Besides the starch and cellulose there is another group of carbohydrates known as *pectin bodies*, which give to fruit their power of forming jellies when boiled, and they are converted into a special kind of sugar known as pentose when digested. Little is known of their exact chemical nature.

Mineral Matter. — In addition to the foods just mentioned there are certain mineral matters needed by animals, but practically all these are found in ordinary fodders in sufficient quantities for their immediate needs. Some of the common minerals found in combinations in the body are salt, lime, soda, and potash. Iron, phosphorus, magnesia, and a few other minerals occur in small and varying proportions. Mineral salts enter into the composition of the brain cartilage, and bone, and thus play an important part in the structure of the body.

The amount of ash or mineral matter in a plant is determined by carefully burning a known amount of the substance over a slow, steady fire long enough to drive off all the organic vegetable matter. The weight of the residue gives the amount of mineral matter or crude ash.

Value of Food. — It is evident that only a part of the food eaten by animals is retained and assimilated by their bodies and the remainder passes off as manure. If an analysis of the food is made and also one of the manure to determine the amount of nutrients remaining, it becomes an easy and simple matter to calculate the

nutritive value of the food used. If we subtract the amount of the nutrients found in the manure from the amount of the same nutrients in the food, the result will show the amount of digested material. According to some authorities a milk cow, a fattening steer, or a work horse will generally need each day about two pounds of digestible protein, twelve or thirteen pounds of digestible carbohydrates, and approximately a half pound of digestible fats. The season of the year, the condition of the animal, and many other things are to be taken into consideration, so that these estimates are only approximately correct.

Nutritive Ratio. — According to Professor Bailey the amount of energy yielded by fats is about two and one fourth times as much as that given by an equal weight of sugar or starch; that is, the fats are considered two and one fourth times as valuable for food stuffs as carbohydrates. The nutritive ratio is the ratio of the digestible protein to the digestible carbohydrates plus two and one fourth times the digestible fat, and the operation may be expressed very conveniently in the following formula :

$$\frac{\text{Carbohydrates} + (\text{Fat} \times 2.25)}{\text{Protein}}$$

For example, if the amount of digestible carbohydrates = 34 and the amount of digestible fat = 1.42, while the amount of digestible protein is about 6.00, we have:

$$\frac{34 + (1.42 \times 2.25)}{6.00} = \frac{34 + 3.195}{6} = \frac{37.195}{6} = 6.199 = 6.2 \text{ approximately.}$$

That means the nutritive ratio is 1 to 6.2 for this particular kind of feed.

A **ration** is the amount of food given an animal during a day or any stated period. Rations are classified as balanced, narrow, medium, and wide, according to the proportion of carbohydrates and fats to the amount of protein.

A **balanced ration** is one in which the proportion of carbohydrates and fats to the amount of protein has been so adjusted or balanced as to give the most satisfactory results with the least possible expenditure. The ordinary limit for a well-balanced ration is

generally placed at 1 to 5.2. Many farmers would find it better to sell a part of their corn and purchase some food stuff, like linseed meal, rich in protein instead of feeding so much corn.

The feeding of unbalanced rations is often not only disastrous to the farmer from a financial point of view, but it is also likely to prove detrimental to the proper growth and development of the stock.

A Narrow Ration. — When the amount of the carbohydrates and digestible fat is relatively small compared with the amount of proteid present, the ratio is narrow and the ration is designated as a narrow ration. Oil meal has a ratio of 1 to 1.7, and a feed made up of this alone would afford only a narrow ration. In fact, any ration less than one to five may be designated as a narrow ration.

A Wide Ration. — When the amount of carbohydrates and digestible fat is relatively large compared with the amount of protein on hand, the ratio is large and we have what is designated as a wide ration. For example, the nutritive ratio of oat straw is 1 to 33.7, which would make it a feed having a wide ration. Any feed in which the ratio is much over 1 to 9 would be regarded as a feed of wide ration.

A Medium Ration. — When the nutritive ratio is not less than 1 to 6 nor more than 1 to 10, the ration is designated by some authorities as a medium one. Thus in common maize or Indian corn, which has a ratio of 1 to 9.8, we have an example of a medium ration.

Feeding Standards. — Many trials or feeding experiments have been made for the purpose of determining the proper ratio of the carbohydrates and fats to the amount of protein necessary, but the standards generally accepted are those prepared originally by Wolff and subsequently modified by Lehmann. (See Tables 1, 2, and 3, Appendix.) These standards must not be followed slavishly, but should be modified as circumstances may seem to demand. Such standards, however, are useful as a basis of comparison and as guides in the selection of proper food stuffs in making up rations.

Compounding Rations. — It is evident that we must combine several kinds of foods in order to secure the proper proportion of

the necessary nutrients. With roughage we must use a certain amount of concentrates in order to obtain a balanced ration.

If we were to use a ration composed of

Clover	.	.	.	.	.	10 lb.
Oats	.	.	.	.	.	10 lb.
Oat Straw	.	.	.	.	.	5 lb.

and desired to know whether this would prove a suitable ration for a horse doing light work or heavy work, the only thing required would be to find the nutritive ratio as follows:

Amount of digestible carbohydrates:

$$\text{In 10 lb. of clover hay} = 10 \times \frac{35.8}{100} = 3.58$$

$$\text{In 10 lb. of oats} = 10 \times \frac{47.3}{100} = 4.73$$

$$\text{In 5 lb. of oat straw} = 5 \times \frac{38.6}{100} = 1.93$$

$$\text{Total amount of carbohydrates} = 10.24$$

Digestible fat or ether extract:

$$\text{In 10 lb. of clover hay} = 10 \times \frac{1.7}{100} = .17 \text{ lb.}$$

$$\text{In 10 lb. of oats} = 10 \times \frac{4.2}{100} = .42 \text{ lb.}$$

$$\text{In 5 lb. of oat straw} = 5 \times \frac{0.8}{100} = .04 \text{ lb.}$$

$$\text{Total amount} = .63$$

Amount of digestible protein:

$$\text{In 10 lb. of clover} = 10 \times \frac{6.8}{100} = .68$$

$$\text{In 10 lb. of oats} = 10 \times \frac{9.2}{100} = .92$$

$$\text{In 5 lb. of oat straw} = 5 \times \frac{1.2}{100} = .06$$

$$\text{Total amount} = 1.66$$

Hence,

$$\frac{10.24 + (2.25 \times .63)}{1.66} = \frac{10.24 + 1.418}{1.66} = 7 \text{ approximately;}$$

that is, the nutritive ratio is 1 : 7.

By consulting Table 1, Appendix, it will be found that this is the nutritive ratio for a horse when only light work is required of it. Would the amount of the ration required be greater for a horse weighing fifteen hundred pounds? Why?

General Suggestions on Feeding. — The careful feeder will take pains to see that his stock are neither overfed nor underfed. In order to do this he must know the composition of the various feeding stuffs and their relative values. Stock should have all the feed that they can digest well, but this does not mean necessarily that they should have all that they will eat. Especially is this true of the feeding stuffs known as concentrates. Horses and cattle both are frequently foundered by eating too much corn when a very heavy feed is given them on this alone. Generally a balanced ration will give the best and most satisfactory results. Cattle and sheep should have a ration consisting of two thirds roughage and one third concentrates; for horses the amount should be one half roughage to one half concentrates; while for pigs, hogs, and poultry the proportion of concentrates should be much larger. During the winter months a large amount of dry feed is given stock, and in the spring, when green feed is to be given, the change must be made gradually; and the same rule is to be observed in the fall when stock are changed from green feed to dry feed. Carelessness in this matter is sure to cause trouble. Experience has shown that a certain amount of variety in food is just as essential for animals as for people. There is some difference of opinion as to the number of feeds that should be given stock each day, but whatever is given should always be given at regular intervals. Work horses are generally fed three times per day, but cattle, hogs, and fattening stock are generally not fed oftener than twice a day.

In feeding stock for fattening purposes a number of things must be considered in order to secure the best results. Bulletin No. 76, issued by the Missouri Experiment Station in December, 1907, gives a number of fruitful suggestions in reference to the fattening of cattle and hogs.

In the matter of the most favorable season for fattening cattle a majority of the feeders showed a decided preference for summer or some other season rather than winter. A majority of the

feeders also reported that cattle gained materially faster in summer and at something like four fifths the cost of similar cattle fed in winter. Gains on grass alone were made very cheaply, but the cattle were low-priced because they were not in market-



Grass-fed cattle.

able condition and had to be sold to feeders with sufficient margin to enable the buyer to fit them for market.

The average length of the full feeding period as given in this bulletin was one hundred and seventy-seven days, or practically six months. The opinions as to the kind of steer giving the greatest profit were as follows:

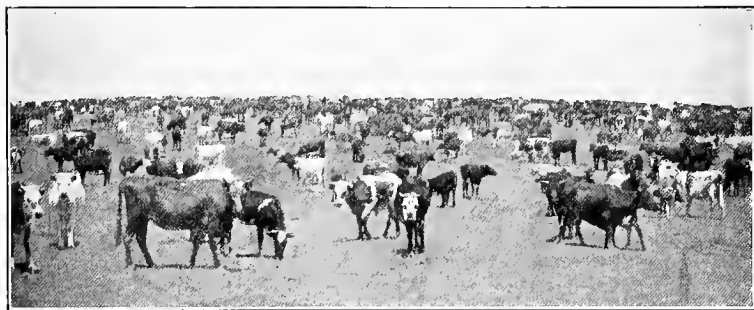
Missouri	.	.	.	.	1345 lb.
Iowa	.	.	.	.	1358 lb.
Illinois	.	.	.	.	1390 lb.
Nebraska	.	.	.	.	1400 lb.

From these reports it would appear that the best average weight for feeding cattle is thirteen hundred and sixty-seven pounds. Feeding cattle weighing from fifteen hundred to sixteen hundred pounds was generally found not very profitable. The average age for feeding cattle full feed was given at two years of age, but a large number of feeders reported in favor of beginning full feed at three years of age.

All the feeders used roughage, but they seemed to think it made no material difference as to the kind or the amount used. The experiments made at the Missouri Station showed that the roughage affected strongly the rate and cost of gain and the

finish of the cattle. It was shown that with cattle bringing five cents a pound, corn when combined with clover or cowpea hay was worth eight and one fourth cents more per bushel than when combined with timothy. The same experiments showed that a large consumption of roughage does not necessarily cause a diminished grain consumption.

Another factor which must not be overlooked in feeding is the buying margin, because on this will depend the profit that may be made in feeding. The gains put on cattle during the fattening process will vary from six cents to ten cents per pound, while the



On a cattle ranch.

steer will bring on the market an average of four to seven cents per pound. This situation is met by lowering the price at which the steer in thin condition may be purchased, and places the burden of the expense of the fattening process upon the cattle raiser rather than on the feeder or the meat consumer. The average margin for a six months' feed in summer is estimated at \$1.02 per hundred on two-year-old cattle, while for a similar feed in winter an approximate margin of \$1.50 would be required.

Stock fed under shelter and in well-ventilated barns do not gain so rapidly nor so economically as those fed in an open shed or those confined in an open lot, so that it seems the question of providing stables is not so important as one might think. It is always well, however, to provide shelter from storms and dampness, as most breeds of cattle are not prepared to weather snow and cold rains without discomfort and harm.

Comparing the relative profits on cattle and hogs on the Chicago market for the past twenty-four years, it has been found that the hogs have brought a higher price per pound, and experiments show that less food is required to make a pound of gain on hogs than on cattle. From this it appears that hog feeding is more profitable than cattle feeding. The reports of the other market centers of the West, in Ft. Worth, Kansas City, and St. Louis, seem to bear out this statement.

The number of hogs required to utilize the waste per steer, according to the Reports of the Missouri Experiment Station, will vary greatly with the character of the feed, the way in which it is prepared, and with the size and age of the cattle. The range is given as from two to three hogs per steer on snapped-ear corn, one and one half on husked-ear corn, about one on shelled corn, and from one third to one half a hog per steer on crushed or ground corn.

Another important feature in stock feeding that should receive more attention than is usually given it is the matter of providing an abundant supply of pure water near the place of feeding. The use of water troughs for this purpose will generally be found advisable. The students should send to their State Experiment Station for any bulletins that may be published on feeding cattle, hogs, sheep, mules, or other stock. It will also be found interesting to secure the bulletins from other States and to make comparisons of the results and the various conclusions reached.

EXERCISES

1. Ascertain the weight of each of the following: (a) a bushel of corn, (b) a bushel of oats, (c) a bushel of wheat, (d) a bushel of rye.
2. Refer to Table 2, Appendix, and calculate the amount of digestible protein in a bushel of corn as compared with a bushel of oats.
3. Compare the amount of digestible carbohydrates in a bushel of oats with a bushel of cowpeas.
4. According to Table 1, Appendix, how much food is required for a ration for a horse of one thousand pounds doing light work? What is the nutritive ratio?
5. What is the amount of food that would be required for three milch cows giving sixteen pounds of milk daily?

6. Determine the nutritive ratio in a feed of ten pounds of red clover hay and ten pounds of oats.
7. According to the table this would be a ration for a horse doing what kind of work?
8. Determine a ration for a milch cow composed of red clover, oat straw, wheat bran, and green fodder corn with a ratio of 1:7.
9. Calculate a suitable ration for fattening cattle in the first period consisting of corn and two kinds of roughage.
10. Calculate a suitable ration for fattening swine in the second period.
11. Calculate a ration for growing cattle of eight hundred and fifty pounds and aged eighteen to twenty-four months containing one concentrate and two kinds of roughage.
12. If it takes six tons of hay, one hundred bushels of oats, and twenty dollars' worth of pasture to keep twenty sheep a year, what is the cost per head when hay is worth six dollars per ton and oats are worth twenty-five cents per bushel?
13. What feeds have a large percentage of protein?
14. When corn is worth thirty cents per bushel and oats twenty-five cents per bushel, what is the relative cost of the protein in each, and which is the cheaper feed at the prices mentioned?
15. Determine the nutritive ratio of a ration composed of twelve pounds of clover hay, six pounds of oats, and four pounds of cotton-seed meal. Would you vary this proportion? Why?
16. How many head of hogs are required for fifty head of fattening cattle fed on snapped-ear corn? On husked-ear corn? On shelled corn?
17. When corn is worth thirty cents a bushel and fat cattle are worth five cents per pound on the market, what can a farmer afford to pay for stock cattle?
18. From the table calculate the relative amounts of fertilizing materials in a ton of corn.
19. Calculate the amount of fertilizer in two tons of red clover hay and the same amount of cowpea hay.
20. Which contains the greatest amount of fertilizing elements, a ton of corn or a ton of oats? Explain.

QUESTIONS

1. Name the objects of feeding.
2. What is roughage? What are concentrates?
3. Name the classes of foods or feeds.
4. Discuss albuminoid feeds.
5. Describe the fats and the carbohydrates.
6. Discuss (a) cellulose, (b) starch, (c) sugars, (d) gums, (e) pentose.
7. What is said of mineral matter?
8. Discuss the value of food.
9. Explain what is means by nutritive ratio.

10. Discuss rations.
11. Discuss (a) balanced rations, (b) narrow rations, (c) wide rations, (d) medium rations.
12. What is said about feeding standards?
13. Explain how rations are compounded.
14. Give some general suggestions on feeding.
15. What kind of ration generally gives the best result?
16. What is the most favorable season for feeding? Why?
17. What is the average length of feeding period for cattle?
18. What is said of the buying margin?
19. Discuss the value of roughage. Discuss value of shelter.
20. How many hogs should there be to each steer in feeding cattle?

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XLIH. ANIMAL HUSBANDRY

Farm Animals.—Animal husbandry treats of the raising and the proper management of animals, whether for home or market use or for their products. It includes stock raising, dairy husbandry, poultry raising, fish culture, oyster farming, bee culture, and other subjects of a similar nature.

A large part of the farm products are converted into animal products before they are available for the use of man. We have already learned that it is poor farm economy to sell all the farm crops from year to year, unless the prices are high enough to cover the cost of additional fertilizers, as this rapidly exhausts the soil and leaves it in an impoverished condition. It is generally better to feed the crops to animals that are kept on the farm so that a large portion of the fertilizing elements may be returned to the soil. By referring to Table 2, Appendix, it is an easy matter to calculate to what extent soil improvement will take place, in a field where cattle or other stock are fed. This will be better understood if we study the reasons for keeping domestic animals.

These reasons are as follows: (1) to furnish directly or indirectly food, clothing, and other products of value to man; (2) to act as beasts of burden or all work; (3) to aid in maintaining the fertility of the land; (4) to provide a means of disposing of the crops; (5) to diversify agricultural occupations; (6) to afford employment to the farmer during the winter and inclement weather when outdoor farm work would be impossible; (7) to assist in keeping the farm clear of weeds; (8) to serve as companions under certain conditions.

Many animals will be found profitable in one part of our country and unprofitable in another place. A close and careful study should be made of the cost of keeping various animals and the returns that the farmer may reasonably expect. This involves to a certain extent a study of the functions or offices of domestic animals.

The Animal and the Soil. — Attention has already been called to the importance of feeding crops on the farm to stock instead of selling them. In pasturing practically all the fertilizing elements are returned to the soil in the form of manure. In stable feeding the manure can be collected and scattered later over the farm.

The Animal and the Crops. — Frequently the market is glutted with grain and other crops, and the gain or profit to the farmer which he has a right to expect can only be realized by feeding the crops to stock. As a rule, the farmer who sells all his crops does not prosper ; while the farmer who handles stock in connection with his farming and exercises good judgment in buying his stock is successful.

The Animal as an Eradicator of Pests. — In weedy pastures sheep and goats have been found very useful in cleaning up the weeds. Hogs also are very serviceable in eating up the larvæ and grubs in the ground and in the fallen fruit in orchards. Chickens and turkeys are useful in catching and destroying grasshoppers and many other injurious insects.

The Animal and Work. — The ox, the horse, the mule, and the burro all play an important part in the work of man. It is true that steam and electricity and the gasoline engine may be made to do much of the work formerly required of animals, but these utilities will never entirely supplant the use of animals. There will always be a demand for animals in plowing, hauling, driving, and as the source of power for driving farm machinery, in spite of the great advances made in cheapening the use of steam and electricity.

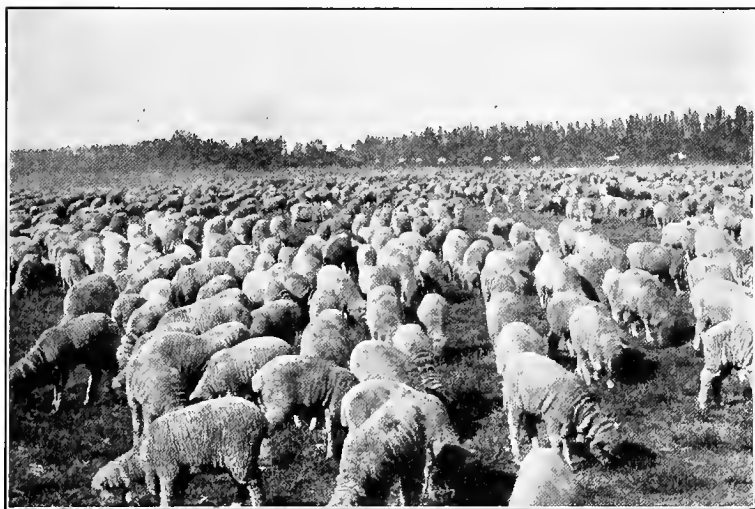
The Animal and its Products. — A great deal of our food, such as pork, beef, mutton, poultry, fish, eggs, fresh milk, condensed milk, butter, and cheese, we owe directly or indirectly to animals.

Other valuable products furnished by animals are wool, leather, hair, horn, bone, feathers, glue, and certain waste products valuable as fertilizers.

The Animal and Diversified Farming. — Animals need a variety of foods, and this necessitates a variety of crops. This leads to rotation of crops and incidentally to diversified farm-

ing. The farmer soon learns that the one-crop plan is unprofitable.

The Animal as a Source of Employment in the Winter. — The handling of stock in the winter and inclement weather affords the farmer and his helpers employment at a season of the year when otherwise they would be idle. In the Northern States plowing and the ordinary outdoor occupations of the farmer cannot be carried on during the winter and inclement weather.



Wool producers.

Animals as Companions. — Many animals are valued by man not so much from a commercial point of view as from a social point. Among the animals that might be mentioned in this list are the various kinds of dogs and cats, rabbits, hares, pet squirrels, canary birds and other kinds of songsters, guinea pigs, and the like. The raising and selling of animals of this class forms an important industry in some parts of our country.

Improvement of Livestock. — In our study of plants we learned that many of our common vegetables were developed by careful selection from wild plants and good cultivation. Careful selection and proper mating of animals through many generations have

given us improved animals. The predecessors of the modern plump and well-rounded beef steer were not handsome or well-formed; the razor-back scrub hog stands as a mute witness of the wonderful difference existing between him and the well-developed specimens of the market hogs; while horses and other domestic animals show developments equally great.

These changes have been brought about mainly by selection of the best individuals having certain marked characteristics, carefully mating these individuals, and giving them favorable environment. When a group of animals is secured of marked resemblances and the offspring inherit the same qualities and characteristics, the variety or group is designated as a *breed*. In improving farm animals the stock raiser may have one of three objects in view: (1) to improve the herd or the home stock of the farm, (2) to improve the breed as a whole, (3) to originate new breeds.

Improving Scrub or Mixed Stock. — By grading up his herd or flock with animals of some distinct breed the owner may make it compare quite favorably with the recognized breed.

Improving the Breed as a Whole. — Many stock raisers work chiefly for the improvement of a recognized breed. Individual animals having the regular type characteristics most strongly developed are selected and mated from time to time until a good breed is developed. This method of breeding calls for considerable skill and intelligence and is somewhat expensive.

Originating New Types. — Some stock raisers, in place of trying to improve existing breeds, spend their time and energy in discovering and developing new types. Animals, like plants, frequently develop individuals showing marked variations from the parent type. By properly selecting a number of individuals showing the desired variation and properly mating their offspring, a breed may eventually be developed which will tend to come true to the type. The origination of Polled Durham cattle, Poland China, Duroc Jersey, and Chester White swine in our own country demonstrates what may be done in originating new breeds by improving or amalgamating older breeds. Scientific knowledge seems likely to facilitate this work in the future.

Pure-bred Stock. — Pure-bred animals are those whose parents belong to the same breed.

Scrub Stock. — Animals whose ancestors belong to no distinct breed are designated as scrubs.

Graded Stock. — Grading is the mating of a common inferior animal or scrub parent with one that is highly improved. The mating may be made either way, but it is more practical and economical to have the male for the pure-bred parent. The form, size, color, and useful qualities of the grade offspring generally approximate those of the pure-bred parent rather than those of the scrub parent. If the sire is a pure-bred animal and the female or dam is scrub stock, the individuals of the first generation are called half-bloods or half-breeds. The offspring resulting from the half-blood females and a pure-bred sire are called three-fourths-breeds. When a half-breed sire is mated with a scrub female, the resulting offspring is designated as a quarter breed. The process of improving inferior animals by breeding is designated as grading up. When the process has been continued until the resulting offspring are seven eighths pure, they are designated as high grades.

Crossing. — When parents of two distinct breeds are mated, the resulting offspring is known as a cross. If animals of two species are mated, the offspring is a hybrid. Most hybrids are sterile, and in that case further development of the hybrid type is impossible. The mule is a common example of a sterile hybrid. It is one of our most useful beasts of burden.

Line breeding is the restriction of selection and mating to the individuals of a single line of descent.

Inbreeding is the breeding together of closely related individuals like a sire and offspring or like a dam and offspring, etc. It intensifies blood lines and makes the most of exceptional individuals.

QUESTIONS

1. Discuss animal husbandry.
2. Name the reasons for keeping domestic animals.
3. Discuss animals in reference to (a) the soil, (b) the crops.
4. Discuss animals as (a) eradicators of certain pests, (b) the beast of all work.
5. Name some of our food supplies that we owe to animals.
6. Discuss animals and diversified farming.

7. What is said of animals as a source of employment ?
8. Discuss animals as companions.
9. Discuss live stock improvement.
10. Name the three principles that should guide the farmer in animal breeding.
11. What is meant by pure-bred stock and graded stock ?
12. Discuss crossing.
13. What is (a) line breeding, (b) inbreeding?

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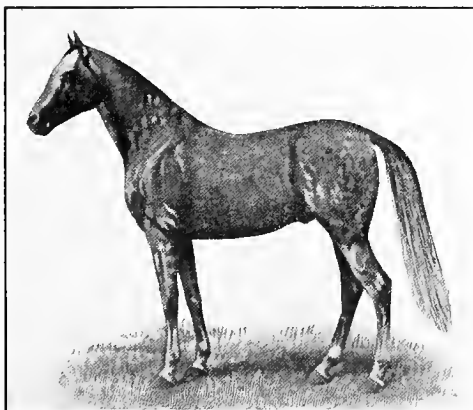
XLIV. DOMESTIC ANIMALS

THE number and kinds of animals kept will depend on the location, on the kinds of crops raised, and to a certain extent on the individual tastes of the farmer himself. The importance of live stock in the economy of the farm is shown by the fact that according to the last Census they represented 15 per cent of the total value of all farm property.

The domestic animals that may be found on farms in this country are as follows: (1) horses, (2) cattle, (3) hogs, (4) sheep, (5) goats, (6) poultry, (7) bees, (8) animals valued as pets or companions.

HORSES AND MULES

Origin of Horses. — The Indian ponies and the wild horses found in the West are all the offspring of horses originally brought from the Old World. Remains of a prehistoric horse have been found in the Northeastern and Middle States, in the Southern States, in California and Oregon, and also in the Bad Lands of Nebraska, Wyoming, and South Dakota; but these had all disappeared long before the early discoverers and settlers came to America from the Old World. It is



Arabian horse.

probable that horses were first utilized for war purposes only, and mention of their use by the Israelites and the Egyptians is made in the Bible. The Greeks and the Romans learned

the value of horses at an early time, and the stories of their famous chariot races will always live in history. The curb bit

we owe to the genius of the Romans and the snaffle bit to the Greeks.

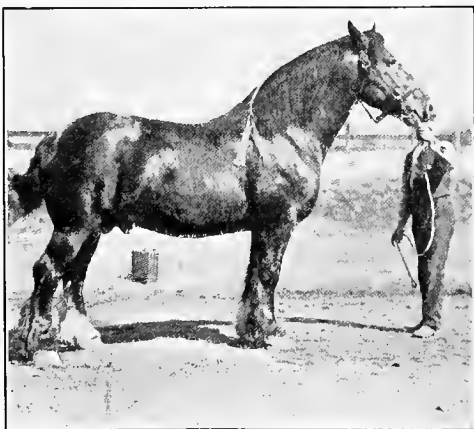
The various breeds of horses have been developed through the influence of different climates and different kinds of food and through the influence of careful and continued selection from time to time of individuals showing certain marked characteristics



French draft horse.

and desirable qualities. The improvement of a great many of our breeds is due in a large measure to the influence of the Arabian

horses. As early as 1603, Arabian horses were brought to England and crossed with native stock. After 1700 many oriental horses were imported into England, and they exercised a strong influence in improving the breeds. Since then many very important breeds have been developed. They may be classed as follows: (1) draft

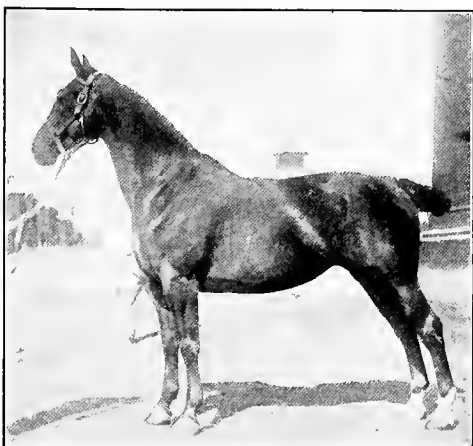


English draft horse.

horses, (2) carriage or coach horses, (3) speed horses, (4) ponies.

Draft horses are those that are specially adapted for drawing

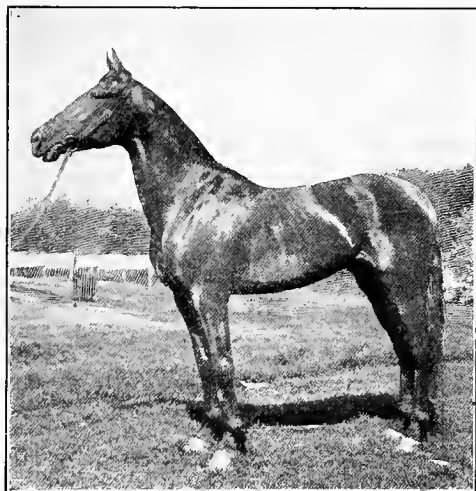
heavy loads. They are usually of heavy build and have broad backs, upright shoulders, and short, muscular legs set wide apart. The leading representatives are the Percheron, developed in France; the Clydesdale, which originated on the river Clyde in Scotland; the Shire, a native of England dating back to the Roman conquest; the Suffolk, which came



Coach horse.

from Suffolk County in the eastern part of England, dating back to 1700; the Belgian draft; and the Boulonnais, a French draft horse somewhat larger and coarser than the Percheron.

All draft horses are large and weigh from fifteen hundred to twenty-five hundred pounds.

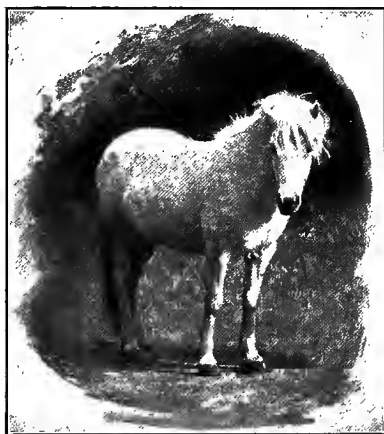


Race horse.

Carriage or coach horses are those used for drawing coaches and vehicles of that class. They are stylish in appearance and lighter than draft horses. They should be about sixteen hands high and should weigh from one thousand to fifteen hundred pounds, according to the breed. Coach horses have a lean graceful head, broad forehead, promi-

nent eye, long arching neck, round full body, long level croup, high carriage of tail, and they must have legs showing cleanness, good bone, and plenty of muscle. The leading breeds are the hackney, with an English ancestry dating back to 1303, or earlier; the French coach, known in France since prehistoric times; the German coach, with an ancestral line dating back five centuries in Germany; and the Cleveland bay, whose native home was on the Cleveland hills of York County, England.

Speed horses have long legs, sloping shoulders, and slender bodies. Some of the leading types are the thoroughbred, derived from the union of Arabian, Barb, and Turkish stock with the lighter English stock, from which was developed an animal of great speed, unusual endurance, and fine symmetry of form; the *American trotting horse*, including such noted families as the Hambletonians, the Mambrinos, the Morgans, and the Clays. The *pacers* also belong



Shetland pony.

to the list of speed animals, but their ancestry does not differ essentially from that of the trotting horses. Some idea of the value of speed animals may be gleaned from the following prices which have been paid for some of them: Arion, \$120,000; Dan Patch, the famous pacer, \$60,000; Nancy Hanks, \$45,000; Sunol, \$41,000; and Maude S., \$40,000.

Ponies are horses of small build, some of which are modeled on the small draft type and others on the trotting-

horse type. The chief breeds are the Indian ponies of the northern and western part of the United States, the mustang ponies of the South and Southwest, and the Shetland ponies brought to various parts of this country from Scotland and the Shetland Islands. The Shetland ponies are very gentle and serviceable for the use of small children. Their average height ranges from thirty-six to forty-four inches.

The Indian ponies and mustangs are the descendants of small horses brought to this country by the early settlers from Spain and France. They are animals of great endurance, but as a rule they are not very gentle or tractable.

Mules.—The mule is a hybrid resulting from crossing a jack on a mare, and is not a true breed. It has been known and valued as a beast of burden since the days of the early Romans and Greeks. Mule raising in the United States dates back to 1787, when George Washington was presented with a fine jack by the king of Spain. Mules are valued chiefly as draft animals, but in some parts of the United States they are used for saddle purposes. Missouri, Kentucky, Tennessee, and Texas furnish the most of the mules in use at the present time. For draft purposes they usually command higher prices than horses because of their greater endurance and strength, their resistance to disease, and their great longevity. Cases are on record where mules have lived to seventy years of age and were still able to do effective work at the age of thirty years.

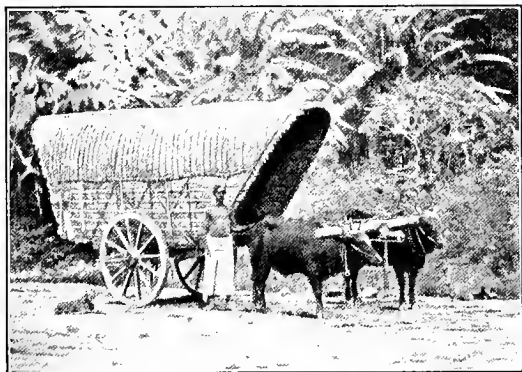
CATTLE

Most of the cattle in this country have been developed from English breeds. The use of cattle dates back to the earliest known times, and in some of the early nations cattle and cattle hides were used as money in the absence of circulating medium.

In the central and western parts of the United States there were formerly great herds of bison, or American buffalo,

as they are sometimes called and some of these have been crossed on some varieties of European cattle to good advantage.

In the Philippine Islands a kind of buffalo is found that serves



Ox cart, India.

as beast of all work. In China, Borneo, Java, and India is found a species of cattle known as zebu cattle which differ in many respects from our own cattle. In these countries they are used to draw plows, carts, and all kinds of vehicles. In the United States oxen have always been used to a large extent in lumber camps, where their services have been useful in logging. One may see large numbers of them in Washington, Oregon, and some of the Southern States.

Cattle are raised principally for beef and dairy purposes. Their hides are valuable for making leather, their hoofs for glue, their hair for plaster, their bones for buttons, ornaments, and fertilizers, and their horns are utilized for making powder flasks, dinner horns, knife handles, and other useful articles.

Beef Breeds.—The chief beef breeds are the Aberdeen-Angus, the Galloway, Devon, Red Polled Cattle, Shorthorns, Polled Durhams, Herefords, Sussex, West Highland, Simmenthal, and native or scrub cattle.

Aberdeen-Angus Breed.—These cattle originated in northeastern Scotland, in Aberdeen County and vicinity. They have compact bodies, polled or hornless head, smooth neck, and prominent shoulders; the back has great relative depth and tends to dip at the withers, and the legs are generally short and finely shaped. The usual color is black.

Galloway cattle.—The native home of the Galloway cattle is the ancient province of Galloway, in the southwestern part of Scotland. The early varieties were horned, but all those of the present time are polled or hornless. The color is generally black, but a brownish or reddish tint in the black is not regarded as objectionable. They are somewhat smaller and coarser in bone and hair than the Aberdeen-Angus, and they are so hardy that they readily withstand all extremes of temperature. The hides of Galloway cattle are especially valuable, when properly tanned, for making fur overcoats, lap robes, and floor rugs.

The Devon cattle originated in the counties of Devon and Somerset in southwestern England. The color of Devon cattle varies from light red to dark red. The hair about the muzzle is of a flesh color, while that about the eyes is a creamy tint. The body is of medium size and the legs are small. The North Devon cattle have

fine flesh and are valued for beef production, while the South Devon cattle are larger, coarser, lighter colored, and are raised chiefly for dairy purposes.

The red polled cattle are natives of Norfolk and Suffolk counties in England. They are useful for both beef and dairy purposes. The head is lean, the withers moderately broad, body well ribbed, hips not prominent, and weight medium. The color varies from light red to dark red. A great many of these cattle are found in Missouri, Ohio, Wisconsin, Illinois, Iowa, and Texas, but they do well anywhere in the Mississippi Valley.

Shorthorns.—The home of the shorthorn cattle is in the counties of York, Durham, and Northumberland in northeastern England. It is our heaviest type of beef cattle and it outnumbers any other breed. Shorthorns are also highly prized for dairy purposes and have good records. Shorthorns have small short horns generally curving forward, short neat neck, body with broad back and large girth, broad brisket, hip bone well covered, rump broad, long, and well filled over with flesh, and thighs and quarters rather long, thick, and deep from front to rear. The color may be solid red, white, red and white, or roan. Among many feeders the pure reds are preferred, but at the stockyards the roans are also highly esteemed. The shorthorns are widely distributed through the Ohio Valley and the Mississippi Valley, but they are not so well adapted to the Western States, where cattle have to shift for themselves on the range. Some blooded shorthorns are quite valuable, and have commanded prices ranging from \$5000 to \$40,600, the latter being the price paid in 1873 for the Eighth Duchess of Geneva.

Polled Durhams.—This breed is derived from the shorthorn and originated in the United States. The characteristics of this breed are as follows: (1) true polled heads, (2) the true colors and recognized markings of the shorthorn, and (3) not less than approximately 96 per cent of shorthorn blood.

The Herefords are natives of Hereford County, England, and are said to have been first introduced into this country by Henry Clay, in 1817, at Lexington, Kentucky.

Herefords have broad foreheads, keen eyes, bright, tapering horns, small head with white face, deep chest, broad loin, wide level hips, broad ribs, clean tapering thigh, short legs, good body and good

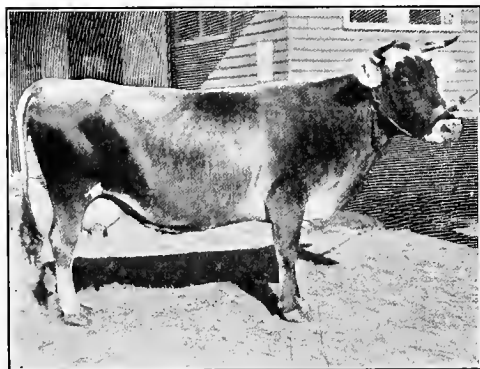
flesh. In a general way we may say that the upper and rear portion of the body is of a middle red color, while the face, sides of the head, belly, and the lower parts of a Hereford's legs are of a striking white.

Herefords are widely distributed west of the Mississippi River, and they are especially well suited to the great ranges in the West, where cattle are frequently subjected to great extremes of temperature while on scant feed. They make good beef cattle, but are not always satisfactory for dairy purposes. In weight they run next to the shorthorns.

Sussex Cattle.—The home of the Sussex cattle is in Sussex County, England, and they were first introduced into this country in 1884 by Mr. Overton Lea of Nashville, Tennessee. They are of a solid red color, have a blocky body, long thick hair, and thick beefy thighs. They resemble Herefords, but differ from them in color.

The West Highland Cattle are natives of the high uplands of Scotland and are said to have been brought to the United States about

1880. They are small cattle, weighing from 900 to 1200 pounds and are very hardy. They produce beef of a very fine quality and flavor.



Brown Swiss cow.

Simmenthal or Swiss Cattle.—There are two distinct races of cattle found in Switzerland that deserve a brief mention here. One of these is the *brown*

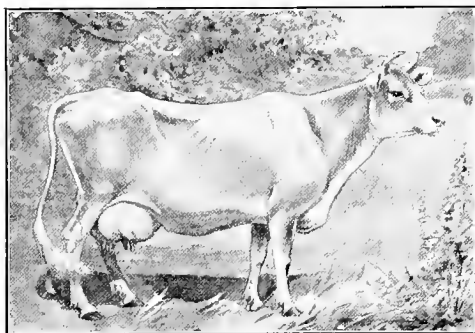
Swiss, and the other the *Simmenthal* or *spotted breed*. It is thought that this breed of cattle is very old. Some of the brown cattle are highly prized for dairy purposes. They were first introduced into the United States, in 1869, by Mr. H. M. Clark, of Belmont, Massachusetts. The Simmenthals are used mostly for beef.

Native Cattle. — These are cattle made up of mixed breeds and scrub cattle. When these are crossed with pure-bred or high grade cattle, sometimes a fair grade of beef cattle is produced.

Dairy Breeds. — Dairy cattle differ notably from beef cattle. Dairy breeds are small but have large stomachs, and wide udders with many large branching milk veins. The head is usually small, the mouth large, the neck long and muscular; the brisket is not so wide as in beef cattle, the chest does not have great thickness, the ribs are long and arched, the hips are somewhat prominent, the thighs are somewhat muscular, and the legs set square with the toes pointing directly forward.

The principal dairy breeds are the Jersey, Guernsey, Ayrshire, Holstein-Friesian, Dutch belted, French Canadian, Kerry, and brown Swiss.

The Jersey Cattle. — The Jersey is a native of the island of Jersey in the English Channel. Its introduction into this country dates back to 1850, at Hartford, Connecticut. The Jersey has a fawn-like color, some being of a lemon or orange fawn, and others being a squirrel-gray fawn. The horns are somewhat short and amber-colored with blackish tips.

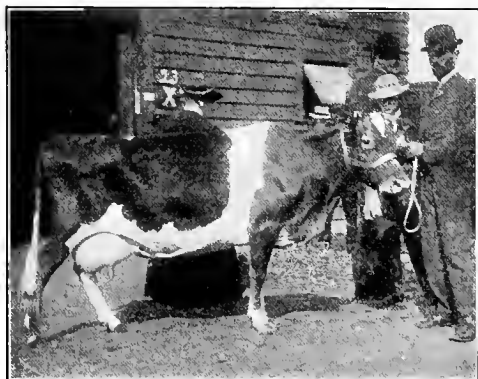


Jersey cow.

The Jersey cows are celebrated for their milk and butter, and it is not unusual for a Jersey to produce five thousand pounds of milk and from four to eight hundred pounds of butter in a year.

The Guernsey cattle originated on the islands of Guernsey and Alderney in the English Channel. They were introduced into the United States, in 1824, by Reuben Haines of Germantown, Pennsylvania. They are larger than Jerseys and also much coarser. Their hair is of a yellowish or reddish fawn color, while the skin is of a pronounced yellow color. The udder is also larger than

that of the Jersey and shows more development in front. Guernseys are highly prized for milk and butter.



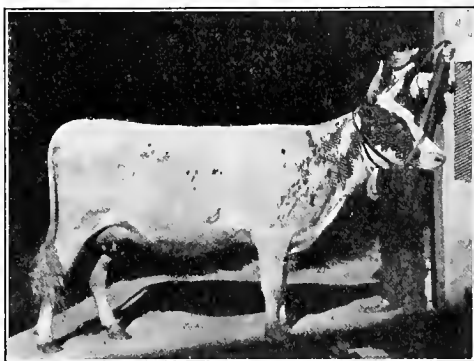
Guernsey cow.

Ayrshire Cattle. —

The native home of the Ayrshire is in the county of Ayr in the southwestern part of Scotland. They are a hardy and thrifty class of cattle and were introduced into this country, in 1822, by H. W. Hills, at Windsor, Connecticut. They are of medium size and vary in color from red or brown to

white. They rank high in quantity of milk, but it is only of average quality. They are especially adapted to short grass ranges.

The Holstein-Friesian Cattle. — These cattle are natives of Holland and they have an ancestry dating back a thousand years or more. They were brought to America by the early Dutch settlers of New York. They are large in body and have long lean heads, well-sprung ribs, prominent hips, and large U-shaped udders. In color the American varieties are

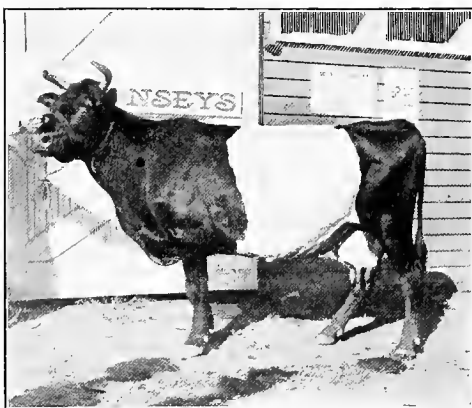


Ayrshire cow.

generally white with black patches or black with white patches, while in Holland many breeds are found in which red and white are the color combinations in place of black and white.

The Holstein-Friesians lead all other breeds in the production of milk. An average cow will produce from seven thousand to nine thousand pounds of milk a year if given the right kind of care, while exceptional cows will give much larger amounts. The milk of the Holstein-Friesian cows contains only from three to four per cent of butter fat, but the large quantity given offsets the low grade of its quality so that it may be profitably used for butter making.

The Dutch Belted Cattle. — Like the Holstein-Friesians, the Dutch belted cattle are natives of Holland, and they were brought to New York, in 1838, by D. H. Haight of Goshen, New York. They are usually of a black color with a large belt of white extending like a blanket around the body. They are found present in New York, New Hampshire, Pennsylvania, Massachusetts, Mississippi, California, and Ohio. In size the Dutch belted cattle



Dutch belted cow.

are much smaller than the Holstein-Friesians. Their yield in milk usually ranges from eight thousand to nine thousand pounds per year.

The French Canadian. — These cattle are supposed to be the descendants of cattle brought originally from Normandy and Brittany in France to the province of Quebec in Canada. They are very hardy and resemble the Jersey. Their color is a solid black or black with a yellowish fawn stripe along the back. Their horns are generally white with black tips. Their milk is of a good quality, but it is not equal to that of the Jersey or the Guernsey.

The Kerry. — These cattle originated in the Kerry Mountains in the western part of Ireland. They are quite small and range in weight from five hundred to eight hundred pounds. In height

they seldom exceed forty inches. As a milk producer the Kerry ranks very high not only in quality but also in quantity. On account of its ability to subsist on poor and scanty feed the Kerry is sometimes called the poor man's cow.

Dairying. — Milk is a model food which furnishes every element necessary for the nourishment of the body, and it is cheaper and more economical than the equivalent amount of any other kind of food.

The chief dairy products are milk, cream, butter, and cheese. Besides these there are several important by-products, such as skim milk, buttermilk, and whey, which add to the profits of dairying. Formerly our entire supply of butter and cheese was made on the farm, but now these articles are furnished us from the creameries and factories.

Much of the value of these articles will depend on the quality of the milk from which they are made. This is determined by sampling the milk and ascertaining the amount of butter fat present by means of a Babcock milk tester.

The old method of separating the cream from the milk depended on the action of gravity. The milk was placed in a vessel of any kind and was cooled rapidly to a temperature of 60° F. and was left undisturbed from twenty-four to thirty-six hours. The fat globules, being lighter than the other constituents of the milk, rise to the top and form a layer of cream which may be skimmed off without difficulty. When this process is carried on in shallow pans, we have what is known as the shallow setting of cream. When the milk is placed in cans fifteen to twenty inches deep and set in vessels of water kept at a temperature of 40° or less for twelve to twenty-four hours, we have what is known as the deep-setting system. By the shallow-setting system only about 75 per cent of the butter fat is saved, while by the deep-setting system from 80 to 90 per cent of the butter fat is saved in the cream. In the centrifugal separator the milk is passed into a revolving bowl, where the skim milk, being the heavier, is forced towards the outside of the vessel, and the cream, being the lighter liquid, flows towards the center of the vessel. As the skim milk reaches the outer edge of the vessel it passes into openings of small tubes which convey it to an outer vessel. The cream passes into

the opening of a small tube in the center of the revolving vessel, and is carried off in a constant stream to an outside receptacle.

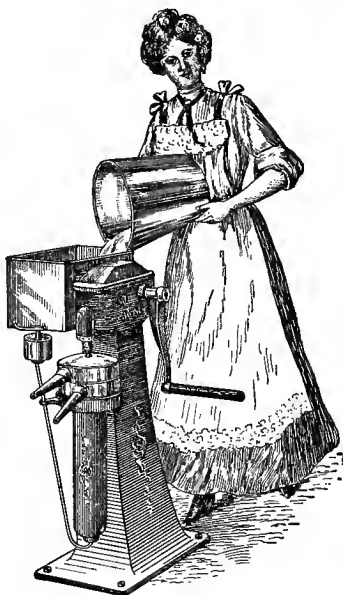
The centrifugal separator ordinarily should be able to remove about 98 per cent of the butter fat in the form of cream.

After the cream is separated it is allowed to ripen before being churned, because butter made from fresh cream seems insipid and lacking in flavor. Under a temperature of 60° this ripening will take place within twenty-four hours or less time. This change is effected through certain bacteria. Besides these beneficial bacteria there are often present many harmful forms of bacteria in milk when it is not properly cared for.

In order to check the growth of harmful bacteria, extreme cleanliness should be practiced, and the milk should be cooled as rapidly as possible to a temperature of 50° or less. Sometimes it is found best to pasteurize the milk. This consists in heating the milk to a temperature of 160° F. for fifteen minutes and then rapidly cooling it to a temperature of 50° F. This destroys many of the bacteria — especially those that are harmful.

After the proper ripening of the cream, it should be churned as soon as possible. The proper temperature of the cream for churning is 50° to 54° F. in the summer and from 54° to 58° F. in the winter. When the butter granules have reached the size of large grains of wheat, the churning should be stopped. Then the butter should be washed, salted, thoroughly worked, molded, and packed for market.

In judging butter and estimating its excellence the student should consider the following points: flavor, texture, color, the salting, and lastly the molding and packing. If possible, send to



Centrifugal separator.

the Director of the Experiment Station in your State and obtain from him the score card used for judging butter in the Dairy Department. Then secure samples of butter and grade them in accordance with the score card used in your State.

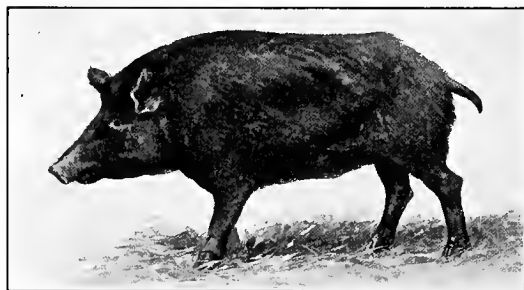
HOGS

Our common hogs are the descendants of the wild hogs of Europe, Asia, and Africa which have been improved under the influence of proper selection and careful handling. They bring in as a rule a better profit on feeding than any other class of farm animals, while the amount required to be invested is smaller than that for most animals.

The principal breeds are as follows:

- | | | |
|-------------------------|--------------------------|-------------------------|
| 1. <i>Small Breeds:</i> | 2. <i>Medium Breeds:</i> | 3. <i>Large Breeds:</i> |
| Victoria | Berkshires | Chester White |
| Suffolk | Poland China | Improved |
| Essex | Duroc Jersey | Yorkshire |
| Small Yorkshire | Cheshire | Tamworth |

Small Breeds. — *The Victoria* is the outgrowth of the combined blood of the Poland China, Berkshire, Chester White, and Suffolk



Texas razor-back hog.

under the influence of careful selection. The head is moderately broad, ear of medium size, body broad and deep, while the shoulders and hams carry a considerable thickness.

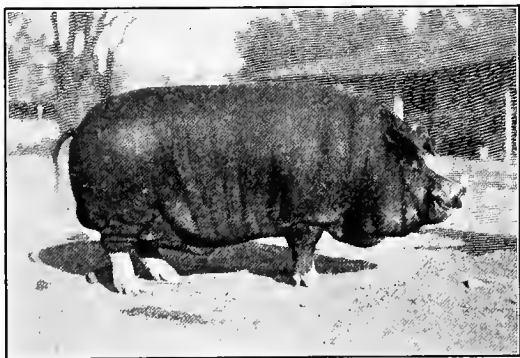
The American Suffolk Hog is of

white color and is probably a descendant of the small Yorkshire. It has a small head, dished face, small snout, fine jowl, short thin ears, short thick neck, wide and deep chest, ribs well arched, broad level back, and well-filled flanks. It is found mainly in the Mississippi Valley.

The Essex is a native of Essex County, England, and was brought to America about 1820. It is of a black color and has a short head, slightly dished face, broad forehead, small fine ears, broad jowl, short neck, broad back, thickly fleshed shoulders, heavy set hams, and short legs. The Essex is a good feeder and its meat is of a fine flavor. It is found in Texas, Nebraska, and the Mississippi Valley.

The Small Yorkshire was developed in Yorkshire, England, and is known there as the *small white*, but its exact ancestry is not known. It was first brought to the United States about 1860. Some of its characteristic features are fineness of bone, quantity and quality of hair, shortness of snout, and aptitude for fattening. Another peculiarity is the occurrence occasionally of black spots on the skin. This breed is found in New York, Massachusetts, Pennsylvania, and the Middle West. They fatten readily on grass, but do not make large gains.

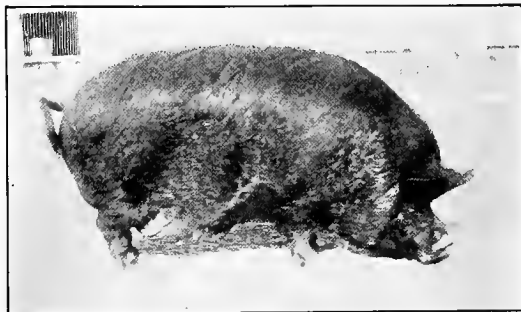
Medium Breeds. — *The Berkshire* is a native of England and is the outgrowth of crosses on the native stock with Chinese, Siamese, and Neapolitan stock. They mature early, and are easy to fatten. They have a gracefully dished face, thin erect ears, the jowl moderately full, shoulders of medium thickness, and hams somewhat deep and thick. They are generally black with a white streak in the face, four white feet and more or less of white on the tail, making up the six white points required for recognition of the breed. Some of the purebred Berkshires command fancy prices ranging from \$500 to \$3000.



Poland China hog.

The Poland China Hog originated in Butler and Warren counties in southwestern Ohio. The head is of medium length and the face

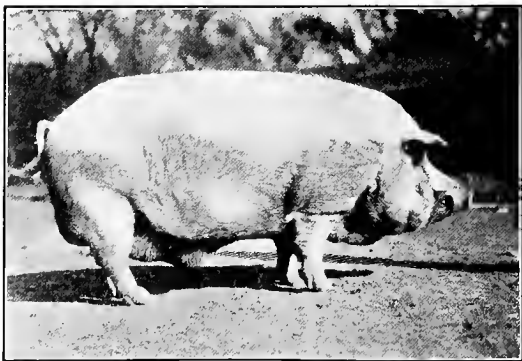
is straight. The cheeks are round and the ears are fine and break over at the upper third and form a droop, the neck is short and thick, the shoulders stand up well, the back has a long gradual arch, while the hind quarters are characterized with a



Duroc Jersey hog.

heavy growth of flesh. This breed is a decided black, but has white feet, white tail, and white face. These hogs are raised widely throughout the corn-growing States and command high prices on the market.

The Duroc Jersey. — This breed of hogs is the result of the amalgamation of the *Jersey red* and the *Duroc red* and possibly of the *old Sandy*, all colored Berkshires. The Duroc Jerseys are of light or dark red color, and they have medium or small head, face either straight or slightly dished, drooping ears, great depth of body, short legs, and heavy thick shoulders and hams. They are good grazers and feeders, but seem to thrive the best in the corn-growing belt; they also give satisfactory results in the South.



Chester white hog.

The Cheshire is a native of Jefferson County, New York,

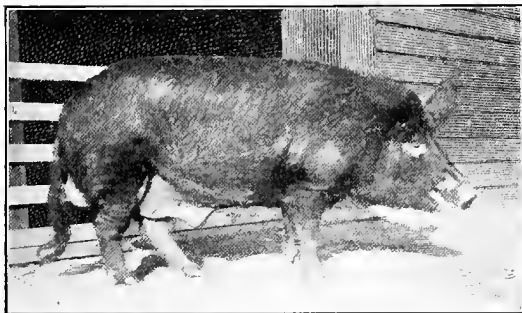
and its origin dates back to about 1855. It has a face only slightly dished, and small fine ears that point forward, a wide and slightly arched back, and thick shoulders and hams. The flesh is fine-

grained and is juicy and tender. In color both skin and hair are white. Experiments show that they gain more rapidly than other breeds of hogs, but they require much more food.

Large Breeds. — *The Chester White Hogs* take their name from Chester County, Pennsylvania, where they first became prominent. Their color is pure white, and the head is short and slightly dished. The Chester whites have large compact bodies, with thick, heavy, drooping ears. They often weigh one thousand pounds or more. They rank high as feeders and command good prices.

Improved Yorkshire. — The modernizing of the *old large Yorkshire* began about the middle of the nineteenth century. The improved Yorkshire has a medium long head with but little upward curve, heavy drooping ears, good-sized hams, white hair, and pink skin. They are generally very large and weights of twelve hundred are not uncommon.

The Tamworths. — This breed came originally from the counties of Stafford, Warwick, Leicester, and North-



Tamworth hog.

ampton in England, and it dates back to the time of Sir Robert Peel in 1812. Their introduction into the United States dates from 1882, when they were imported by Mr. Thomas Bennett of Rossville, Illinois. They have golden red hair and are extremely long in head, legs, and body. Their ears are large and erect, their backs narrow and long, and their sides long and deep. They are fairly good feeders and rank high as grazing hogs or rustlers. They are highly esteemed for bacon.

SHEEP

Sheep were probably domesticated at a very early period in the history of man. They are found in practically every part of the world, and in many parts of the United States and Australia sheep

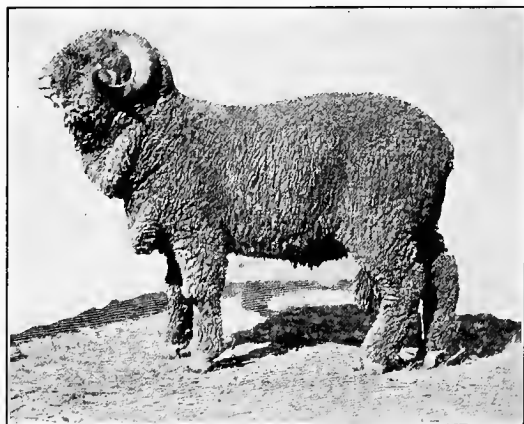
raising is a very important industry. They are raised for their wool and mutton in this country, and also in Europe, Australia, and Asia.

They are usually classified according to the fineness of their wool as follows:

1. <i>Fine-wooled</i>	2. <i>Medium-wooled</i>	3. <i>Long-wooled</i>
<i>Breeds:</i>	<i>Breeds:</i>	<i>Breeds:</i>
American Merino	Southdown	Leicester
Delaine Merino	Shropshire	Lincoln
Rambouillets	Horned Dorset	Cotswold
	Hampshire Down	
	Oxford Down	
	Cheviot	

Fine-wooled Breeds. — *The American Merino* is a descendant of the Spanish merino. The first merinos are said to have been brought to the United States, in 1793, by William Foster of Boston, Massachusetts.

It has large wrinkles on its neck and body and has a very fine wool of a lustrous white color. It is not valued highly as mutton.



French merino.

The Delaine is a development of the merinos. Delaines are somewhat larger and their bodies are freer from wrinkles, and they usually have polled heads, but if horns are present they are small.

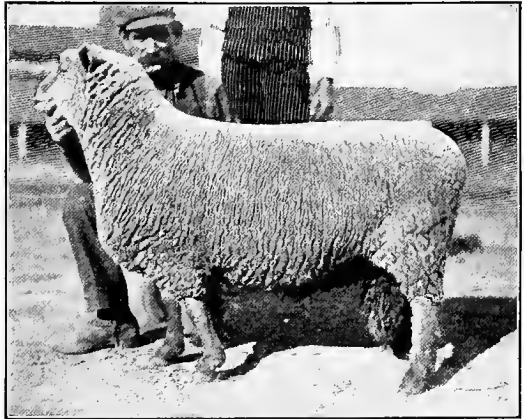
The Rambouillets come from the northern part of France, not far

from Paris, and they are sometimes called the French merinos. They are the descendants of Spanish merinos taken by M. Gilbert

from Spain to France in 1786. The French merinos were brought to Hartford, Connecticut, in 1840. They have large bodies and the wool is very compact and very long, often being over three inches in length. They mature early and are very hardy.

The medium-wooled breeds are sometimes classed as mutton sheep, since their flesh is prized more highly than their wool.

The Southdowns are natives of Sussex County, England. They are rather small, have short wool, and are hornless. They are good feeders and mature early, and



Southdown.

their flesh is of fine flavor. Their use in America dates back to colonial times.

The Shropshires came originally from Staffordshire and Shropshire, England, and were first brought to the United States by Samuel Sutton of Maryland, in 1860. They are larger than the Southdowns and they



Shropshire.

have faces, ears, and legs that are generally of a dark brown color. They rank well as wool producers and general-purpose sheep.

The Horned Dorsets are natives of Somerset, Wilts, and Dorset counties in England, but their introduction in this country

dates back only to 1885. They are larger than the Southdowns, and both the males and females have curving horns. Their faces, legs, and hoofs are white. Another one of their striking features is a short foretop of wool.

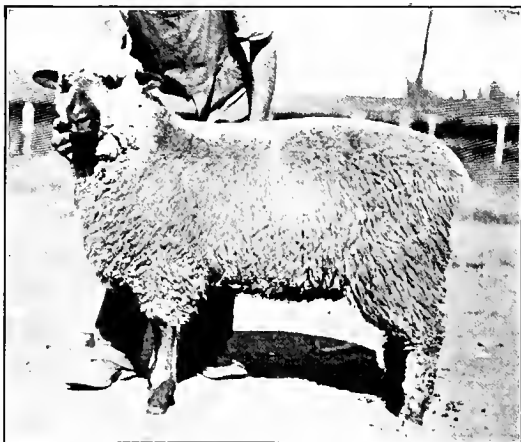
The Hampshire Downs. — The native home of the



Hampshire Down.

Hampshire Downs is in Hampshire County, England, and they were brought to New York in 1855 by Thomas Messenger.

They are larger and coarser than the Shropshires. The head is of a dark brown color, while the lips and nostrils are black, and the ears are of a dark mouse color. They also generally have a pronounced Roman nose. They mature early, fatten rapidly, and are good grazers.



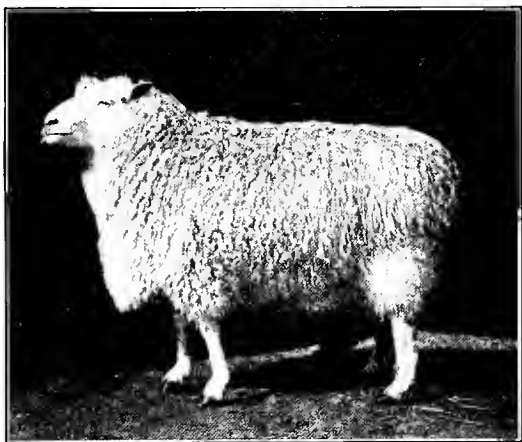
Oxford Down.

The Oxford Downs are natives of Oxford County, England, and were first brought to Delaware, in 1846, by Clayton Reybold. They resemble the

Shropshire, but are of a lighter brown and have less wool on the forehead. The Oxford Downs are large and heavy and are good wool producers. They are good feeders and are quite prolific.

The Cheviot. — The home of the Cheviots is in the hills in the border country between England and Scotland, and they were brought to the United States, in 1838, by Robert Youngs of Delhi, New York. They have polled heads covered with short, fine, white hair. The lips and nostrils are black, or nearly so, while the ears and legs are white and comparatively free from wool. The Cheviot compares favorably with the Shropshire in size, and it ranks high as a mutton producer. Its wool is used for making cheviot cloth. The Cheviot breed is very hardy and very prolific.

Long-wooled Breeds. — *The Leicester sheep* are natives of Leicester County, England, and their introduction into this country dates back as early as 1800. They are somewhat large, and have long wool of white color. The head is covered with soft, white hair, the face is of medium length, the neck is short, the legs are long, and the breast is quite prominent. The Leicesters produce an excellent grade of long wool, but they rank low as mutton producers.



Lincoln.

The Lincoln Breed. — The home of the Lincoln breed is in Lincoln County, England, and the introduction of these sheep into the United States took place over a century ago. The Lincoln sheep are white, and they have large hornless heads, large broad ears, broad level back, and firm flesh. They have

long and somewhat coarse wool, but as mutton producers they do not rank high.

The Cotswolds are natives of the Cotswold Hills of Gloucester County, England, and they were brought to Albany, New York, in 1832.

They generally have polled white heads with curls or locks extending almost to their nostrils. Their fleece occurs in somewhat large locks or curls. They rank high as wool producers, but are regarded as ordinary for mutton purposes. They are both good feeders and grazers.

Other long-wooled breeds are the Kent, of Kent County and the Romney Marsh, in England, and the Black-faced Highland of Scotland.

GOATS

Large herds of goats are not often seen in the United States. They are distributed chiefly in the North Central States, and in Maryland, Massachusetts, and New York.

They may be divided into the following classes :

1. *Fleece Breeds*

The Angora
The Cashmere

2. *Milk Breeds*

The Maltese
The Toggenburg
The Saanen
The Appenzell
The Schwarzthal
The Langensalzer
The Nubian

The Fleece Breeds. — *The Angora* is a native of Angora in Asia Minor, and they were first brought to the United States in 1849. From the fleece of the Angora goat is prepared the mohair cloth of commerce.

The Cashmere goat is a native of Cashmere, Thibet, and the adjacent countries. The costly cashmere shawls and other genuine cashmere goods are made from the fleece of these goats.

The Milk Breeds. — Among some of the poorer classes of people of Europe and Asia, goats are valued highly for their milk. The Maltese goat is a native of the island of Malta, where there are

no less than thirty thousand of them. The Toggenburg goat is of a medium brown color and is a native of the Toggenburg Valley in Switzerland. The white Saanen goat, the Appenzell goat, and the Schwarzthal goat are also natives of Switzerland. The Langensalzers are natives of Thuringia and central Germany. while the Nubian goats are found in Nubia, Abyssinia, Upper Egypt, and South Africa.

POULTRY

The ordinary farm fowls, chickens, turkeys, ducks, and geese, are the descendants of wild fowls which have been domesticated and changed under the care of man.

Chickens. — The principal varieties of chicken breeds are as follows :

I. *Meat Breeds*

- | | | | |
|-------------|-----------------|------------------------|---------------------------------------|
| 1. Brahma | { Light
Dark | 2. Cochin | { Buff
Black
Partridge
White |
| 3. Langshan | | 4. Cornish Indian Game | |

II. *Egg Breeds*

- | | | | |
|------------|------------|------------|------------|
| 1. Leghorn | 2. Minorca | 3. Red Cap | 4. Spanish |
|------------|------------|------------|------------|

III. *General Purpose Breeds*

- | | | |
|------------------|----------------|---------------------|
| 1. Plymouth Rock | 2. Orpington | 3. Wyandotte |
| 4. Java | 5. Dominique | 6. Rhode Island Red |
| 7. Dorking | 8. Indian Game | |

IV. *Fancy Breeds*

- | | | | |
|-----------|---------|-----------|-----------|
| 1. Bantam | 2. Game | 3. Polish | 4. Sultan |
|-----------|---------|-----------|-----------|

Care of Chickens. — Arrange the chicken yard so that the chickens may have plenty of sunshine. Give them a place where they can have plenty of dust to dust in and straw to scratch in whenever they feel so inclined. The chicken house should be warm, but properly ventilated. The inside of the house should be whitewashed frequently, and an occasional sprinkling with coal oil will also be found advisable. In addition to whatever dry feed may be

given chickens, they should have some green food. Scraps of meat and other articles from the table will also be found valuable for chicken feed. Also see that your chickens have plenty of pure water.

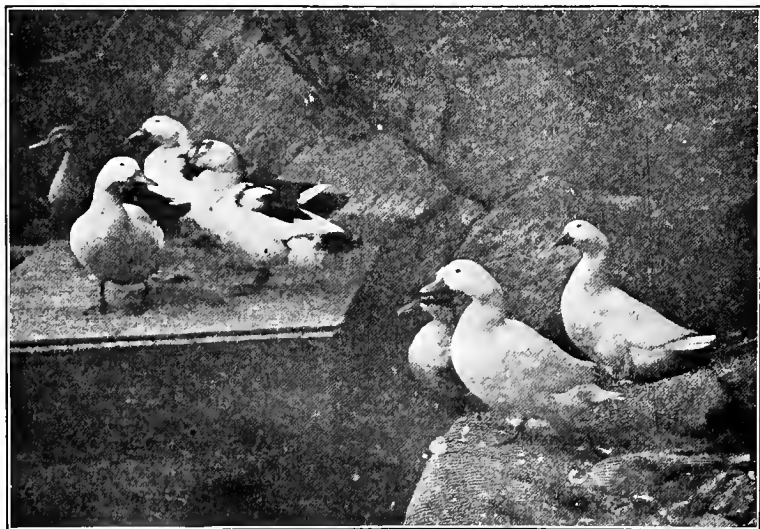


Barred Plymouth Rock pullet.

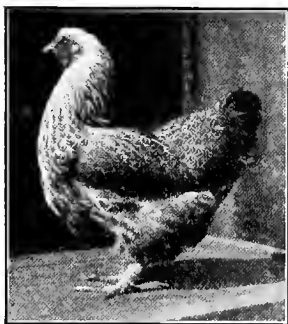
Turkeys. — Our modern turkeys are the descendants of wild turkeys which have been domesticated. Many wild turkeys are still to be found in some parts of the United States.

The chief varieties are the Mammoth Bronze, a large-bodied bird, with flesh of fine and superior flavor ; and the White Holland Turkeys, a hardy breed of German origin.

Ducks are usually found profitable on the farm. The principal breeds are the Pekin, valued for its meat and feathers; the Rouen, a duck of beautiful plumage, the Cayuga, with jet-black plumage ; and the White Aylesburg, of English origin.



Pekin ducks.



Silver-penciled Wyandotte.



Red Cochins.



White Leghorns.



White Plymouth Rock.



Buff Plymouth Rock.

Geese. — Goose raising is very profitable, as the geese need no grain or dry food in the summer when they can have plenty of grass to feed on. The most popular varieties are the Toulouse and the Embdens.

The Toulouse came originally from the City of Toulouse in southern France. They are of a uniform gray color and grow to a large size, many of them weighing as high as forty to fifty pounds. They require but little feeding and live to be thirty years of age.

The Embden geese are about the same size as the Toulouse, but they are of a pure white color. Their feathers are of the best, and they will average at least half a pound of feathers at a picking.

Both Toulouse and Embden geese will average about four pickings a season. Geese are sometimes eaten, but they are valued principally for their feathers.

Guinea Fowls. — Guinea fowls are of a somewhat wild disposition and thrive best when allowed a great deal of range. They are usually of a beautiful blue-gray plumage and of medium size. They are very fond of bugs and worms and destroy a great many of them. Their flesh is of a fine flavor, and their eggs are always in demand for culinary purposes.

Peafowls. — These fowls are raised for ornamental purposes and are not valued for table purposes. Their long tail feathers are of striking colors and are beautifully marked. Sometimes these feathers are utilized for making fly brushes.

The Ostrich. — Ostriches are birds of large size and many of them are from six to eight feet high. Their wings are of small size and are incapable of being used for flight. Their legs are of great size and strength. Ostriches are valued chiefly for the fine plumes which they bear. These are used for making feather boas and for trimming ladies' hats, and for other millinery purposes.

On account of their cost and the difficulty of caring for them, but few ostriches are raised in this country. They are raised principally in Arizona and California. A large ostrich farm is maintained at Phoenix, Arizona, and another large one at Pasadena, California.

ANIMALS VALUED AS PETS

Besides the animals just described there is another class valued principally as pets or companions. This list includes dogs, cats, squirrels, rabbits, guinea pigs, song birds, etc.

Dogs. — These animals have been the companions of man from the earliest times and have always been highly esteemed. The leading varieties are the shepherd dog, the bull dog, the mastiff, the St. Bernard, the Newfoundland, the pointer, the Scotch collie, the English setter, the Irish setter, the retriever, the Italian greyhound, the deerhound, English foxhound, the field spaniel, the terriers, the Chinese chow chow, the French poodle, and others.

Cats. — The domestication of the cat took place at a very early period, and mention of its first connection with man is found in the ancient monuments of Egypt, Babylon, and Nineveh. Among the Egyptians, cats were worshiped as sacred animals and they were inmates of certain temples.

The principal long-haired cats include the Angora, Persian, Chinese, and Indian families of cats. Other prominent breeds are the Maltese, the royal cat of Siam, the Manx cat, and the common short-haired or western cat of various shades and colors.

Squirrels. — The common red squirrel and the gray squirrel if captured while young and reared by hand become quite tame and gentle.

Rabbits. — European rabbits, of which there are many breeds, and Belgian hares, are raised as pets for children.

Guinea Pigs. — These animals are small rodents or gnawing animals, and their native country is Brazil. They are of various colors and are about the size of a large rat, but their bodies are shorter and more blocky.

BEES

In many parts of our country bee keeping may be made a very profitable side line in farming. Especially is this true where there is an abundance of honey-yielding blossoms. White clover, Alsike clover, sweet clover, alfalfa, Spanish needle, basswood, raspberry, sourwood, white sage, aster, blueberry, horse mint, wild pennyroyal, black mangrove, holly, poplar, chestnut,

magnolia, buckwheat, vetch, catnip, and many other plants of like nature furnish flowers which are utilized by bees in making honey.

Breeds. — The principal breeds besides the common black and common brown bees are the Carniolans, Caucasians, Italians, Cyprians, and the Syrians.



Beehives.

The black bees are spiteful and less able to protect themselves against enemies than other breeds. They are also less industrious and produce less honey.

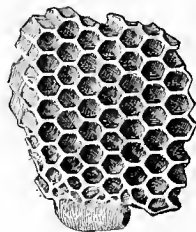
The Carniolans are hardy and very industrious. They were brought to this country in 1884 from Carniola, Austria. They

are quite prolific and breed well in the coldest of climates. They produce a great deal of honey and their honeycomb is snowy white. They are not spiteful and may be handled easily.

The Caucasians were brought to the United States by the Department of Agriculture, and bid fair to become one of our most popular breeds. They are very gentle and kindly disposed, so that they may be handled with impunity. They work industriously and produce a large quantity of high grade honey.

The Italian bees are good workers, but they are not so easily managed as the Caucasians and the Carniolans. Their introduction into this country dates back to 1860, and since then they have gradually spread over a large part of the United States.

The Cyprian bees are very hardy, vigorous fighters against enemies, and they produce a great deal of honey. They are



Honeycomb.

somewhat spiteful when aroused and must be handled with care.

The Syrians are very much like the Cyprians. They are hardy and vigorous and produce a great deal of honey.

The Bee Colony. — Bees live together in colonies and make their homes in hives prepared for them. These hives are usually made in two parts, the lower part being designated as the bee stand and the upper part as the cap. The stand has a small opening at the bottom sufficiently large to admit only a few bees at a time. At the top of the bee stand is another opening of moderate size for the admission of the bees to the cap. Both sections of the hive are fitted with comb racks for the support and attachment of the honeycomb. Each hive should be placed on a small platform and in a sheltered place where it will escape the violence of the wind and storms. Wild bees use hollow trees and crevices in rocks as places in which to make their homes.

Their first energies are devoted to the making of comb, and later this is filled with honey. Sometimes bee keepers assist bees



Drone.



Worker.
Honey bees.



Queen.

in this work by providing them with an artificial comb so that the bees may spend all their time in making honey. Natural honeycomb when not removed from time to time gradually grows dark or yellowish brown.

In the early part of the year each hive will be found to contain three classes of individuals: (1) the workers; (2) the drones; and (3) the queen. Each colony will contain one full-grown queen, a few hundred drones, and from forty to fifty thousand workers.

The Workers. — The working bees are females and are the smallest in the hive. On them falls all the work incident to keeping up the hive. They make the comb, the honey, the beebread, and care for the young bees while in the form of larvæ. The bee cells

are of various sizes, and they are somewhat hexagonal in form. Some are made for holding the eggs which the queen lays, and some for holding honey. In the young bee cells there is also placed the beebread, which is a pasty mass made by the workers from the pollen gathered from flowers. The young bees hatch out and remain in the form of grubs or larvæ for approximately three weeks, when they change their form and become perfect or adult bees. About two weeks later they take to their wings and go out to the field to begin their labors. On account of their strenuous habits the workers live only a few months, but other young bees come on and take their places. Each worker is armed with a sting which she does not hesitate to use when necessary. Since the workers are sterile they are sometimes erroneously called neuters.

The Drones. — The drones are the male bees of the hive and are somewhat larger than the workers. They gather no honey and have no sting. In the fall they are driven out of the hive by the workers, when they starve to death or fall a prey to insect-eating animals. If they attempt to return to the hive, the workers sting them to death.

The Queen. — The queen is mother of the colony, and there is only one to each hive. When the workers desire to produce a queen they usually form a vertical cell and place in it an ordinary worker egg and feed the larva or young bee on a special kind of food known as royal jelly. The queen may be distinguished from the other bees by her long, slender body. A queen bee is very prolific and often lays as many as four thousand eggs in a single day.

Swarming. — As soon as a new queen is produced, the old queen often leaves the hive and a considerable number of bees accompany her. They settle on a tree or some other object that may be convenient. The limb on which the swarm has gathered may be sawed off and the bees shaken down into a new hive. If other queens are produced, another swarm will follow the second queen from the hive as soon as the third queen is produced. Finally, when the hive has been sufficiently reduced in numbers, the workers after accepting a new queen destroy the remaining queen cells, and the ruling queen seeks out the young queens and destroys them by stinging them to death. The queen usually begins to lay her

eggs in midwinter or very early in the spring, and in consequence many new bees come out of their cells every day, during the warm season, and thus the stock of the hive is kept replenished. The queen lays her eggs in three distinct classes of cells, the smallest cells producing the workers, and the next larger horizontal cells producing the drones, and the long vertical cells on the edge of the comb producing the queens. The kind of food fed to each cell also helps to determine the kind of individual that will be developed.

Care of Bees.—The enemies of bees are toads, lizards, and spiders, and the hives must be so constructed that the bees will be protected against their attacks as much as possible. The kingbird and swallow probably attack and eat only the drones. Other enemies that must be guarded against are moths and mice. Mice may be kept out by lining the entrance with tin.

In taking honey from the hives care should be taken not to leave any honey lying about to attract robber bees or other enemies.

QUESTIONS

1. Name the different classes of domestic animals.
2. Discuss the origin of the horse.
3. Name the four classes of horses.
4. Discuss the breeds suitable for draft purposes.
5. Describe the coach horses.
6. Discuss the speed horses.
7. What is said of pony breeds?
8. Discuss mules.
9. Give a brief history of the development of domestic cattle.
10. Name some of the uses of cattle.
11. Name and discuss the beef breeds.
12. (a) Name and discuss the dairy breeds. (b) Discuss dairying.
- (c) Describe the separator. (d) Discuss butter making, etc.
13. Name the principal classes of hogs.
14. Discuss the small breeds.
15. What is said of the medium breeds?
16. Discuss the large breeds.
17. Name and discuss the fine-wooled breeds of sheep.
18. Discuss the medium-wooled breeds.
19. What is said of the long-wooled breeds?
20. What is said of goats and their uses?
21. Name (a) the meat breeds of chickens, (b) the egg breeds.
22. Name (a) the general purpose breeds, (b) the fancy breeds.

23. What is said of turkeys?
24. Discuss ducks and geese.
25. Discuss (a) guinea fowls, (b) peafowls.
26. Give a brief discussion of the animals valued as pets.
27. What is said of beekeeping?
28. Describe (a) the Carniolans, (b) the Caucasians.
29. Discuss (a) the Italian bees, (b) the Cyprians, (c) the Syrians.
30. Discuss the colony life of bees.
31. Describe (a) the workers, (b) the drones, (c) the queen.
32. Discuss swarming.
33. Discuss the care of bees.

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XLV. COUNTRY LIFE CONVENIENCES

A GREAT deal of attention has been given to the study of country life and its problems. Much thought has been given to the ways and means of improving country life and making it more attractive; and while much has been learned through the investigations and the report of the National Commission on Country Life appointed by President Roosevelt, only a beginning has been made, and the greater part of the work still lies before us.

The absence of the necessary farm and home conveniences, the strenuous life continually demanded, the general lack of proper ideals, and the pioneer conditions existing in many communities are responsible in a measure for the general disposition of our young people to migrate from the farm to the towns and large centers of population, where there are greater opportunities for enjoyment and improvement.

In attempting to overcome this evil and to better country life and its social conditions our energies should be directed to the establishment of: (1) better homes with modern conveniences; (2) consolidated rural schools; (3) community improvement clubs; (4) rural mail routes; (5) parcels post; (6) postal savings banks; (7) rural telephones; (8) interurban car lines; (9) United States Weather Service; (10) local and county institutes.

Better Homes. — The drudgery of housekeeping will be considerably lightened if the kitchen is supplied with a good cooking range and running water. The rinse water from the kitchen sink should be conducted through a long drainpipe so that it will be emptied at some distance from the house. Every precaution should be taken to prevent the water in the well or the cistern from being contaminated by drainage from surface water and other sources of impurities. All rain water before being used should be passed through a good charcoal filter. As an additional precaution it will be found advisable to have a porous brick partition or wall extending through the center of the cistern and arranged so that the water will filter through it before being used.

Consolidated Rural Schools. — One of the greatest needs is for better schools. In many States the mistake has been made of creating too many small school districts so that only a short term of school is possible. A remedy for such a condition lies in consolidation of two or more of such districts, and maintaining a graded school at some convenient central point in the consolidated district, and providing transportation for the pupils at the expense of the district. This plan relieves the children from the necessity of trudging through the snow and mud. Special wagons are now made for this purpose having curtains, lap robes, and



A modern country schoolhouse.

everything else necessary for the protection of the children in cold weather. In some States township graded schools are maintained and have been found very satisfactory. Occasionally small primary schools are maintained in some parts of the consolidated district for the benefit of the very small children.

Not only should the course of instruction given be carefully graded, but it should be especially arranged with reference to the needs of country life. According to Superintendent O. J. Kern of Winnebago County, Illinois, the consolidated country school offers the following advantages over the average country school:

"1. There will result the inspiration and interest that always come from numbers.

"2. Stronger classes will be thus formed, giving the teacher more time for the recitation and for the necessary instruction.

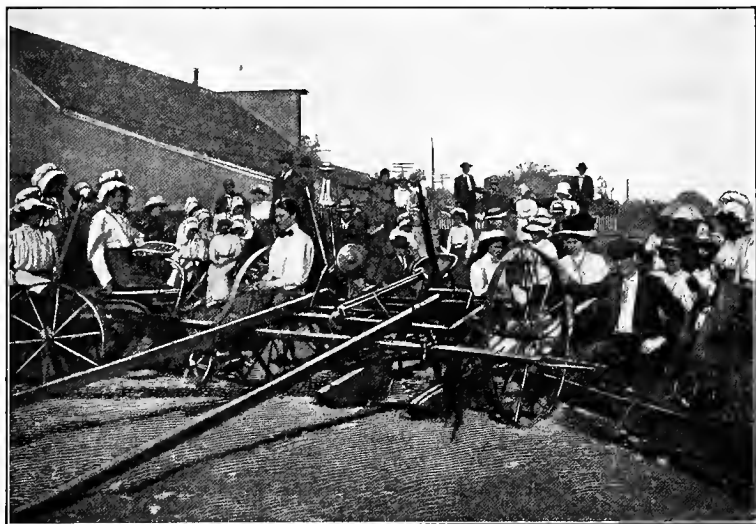
"3. There will be better trained teachers for the country children, and these teachers will command and receive better salaries.

"4. There will result greater economy in school buildings and equipment.

"5. The school year of the country child will be lengthened and high school privileges may be afforded him.

"6. Such a school will afford time and opportunity for systematic instruction in the elementary principles of agriculture and domestic science throughout the grades.

"7. Consolidation will help to bring better roads."



Class in agriculture, Weatherford, Okla.

The first State to take a stand in favor of consolidated school districts was Massachusetts in 1869, and since then the following states have also made provisions for consolidation of country schools: Connecticut, California, Florida, Indiana, Illinois, Iowa, Kansas, Maine, Nebraska, New Hampshire, New Jersey, New York,

North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Dakota, Vermont, and Wisconsin.

Community Improvement Clubs. — The progressive people of every community should organize a club to sustain the same business relationship to the community as exists between a city and its commercial club. The community improvement club should encourage the establishment of good schools and good school environments, and should also furnish for the community

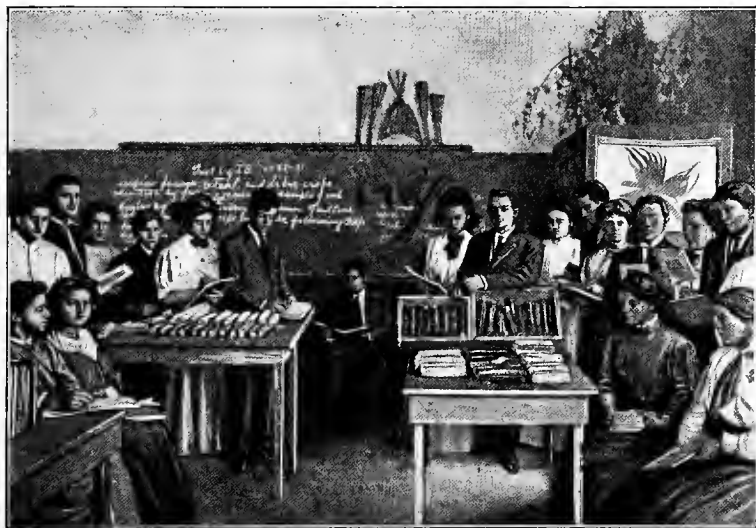


Class in agriculture, Weatherford, Okla., destroying infected branches.

lectures, entertainments, and instructive amusements. The building of good roads, the establishment of churches, libraries, reading rooms, and many other things of like nature that are necessary for the general welfare of the community, should receive the attention of the club. Such an organization when properly managed can be made a power for good in any community.

Rural Mail Routes. — Formerly the farmer had to go to town or to some village in order to get his mail, and generally this necessitated a trip of several miles and meant a considerable loss of time. Under such conditions it was impossible to secure

daily newspapers, and but few letters were written. To remedy this situation the first step was taken by the establishment of the first rural free delivery route at Charleston, West Va., in 1896. This was undertaken as an experiment, but such a generous response was given it by the people that the postal authorities decided to make it a permanent feature of the postal service. In 1897 there were 83 carriers maintained at an approximate expense of \$15,000, while in 1908 there were 39,339 carriers, necessitating an



Class in corn judging, Weatherford, Okla.

expense of about \$35,573,000. Rural delivery is now established on about 1,000,000 miles of roads throughout the country and has a patronage of nearly 20,000,000 people.

Rural mail service has done much to improve conditions in the country, and the possibilities of the good it may accomplish in the future are vast.

When the people of any locality desire to have a rural route established, the heads of families living along the line of the proposed route sign a petition which is filed with the Fourth Assistant Postmaster-general. An inspector is then sent out to look over

the proposed route; and if the conditions are favorable, an order is finally issued for its establishment. The regulations of the Post-office Department require that the roads be in good condition and that there shall be a possible patronage of one hundred families for every twenty-four miles of the route. The postmaster at the distributing office is also required to certify that not less than three fourths of the possible patrons have provided the form of mail boxes approved by the Post-office Department.

The Parcels Post. — For some time the postal authorities have been urging the establishment of a limited parcels post to be confined entirely to rural delivery routes. To protect the small dealers it is proposed that no merchant or dealer not a *bona fide* resident of the town in which the distributing post office is located or on the rural route shall be permitted to have goods delivered at the proposed special rate, and packages shall not be accepted from any person acting as agent for a concern located outside of the delivery limits of the rural routes. Postmaster-general Meyer, in speaking of the proposed service, says: "The special local parcels service will enable the farmers to have small parcels delivered at their gates, to live better, and to obtain easily the necessities of life. The increased consumption will in turn increase the business of the local merchant, and benefit the jobber by the additional orders transmitted through the commercial traveler."

In all countries where a parcels post service has been in operation it has been found very satisfactory and popular, besides being a source of large revenue to the Post-office Department.

Postal Savings Banks. — In 1908 the United States Comptroller of the Currency reported that there were more than three and a half billion of dollars on deposit in the various private savings banks of the United States. For the same period it was estimated that there were fully half a billion of dollars not placed in any bank, due to a want of opportunity or lack of confidence. In all, then, we have about four billion of dollars that might be placed in postal savings banks if such institutions should be organized.

One of the plans proposed is that the national banks are to pay not less than $2\frac{1}{4}$ per cent for the deposits, the government in turn to pay the depositors 2 per cent, retaining one fourth of 1 per cent in order that the system may be self-sustaining.

In speaking of the desirability of postal savings banks Postmaster-general Meyer says: "Postal savings banks would foster thrift and increase the habit of saving in many States and localities where opportunities for depositing savings do not now exist, and would in the end serve as feeders to the regular stock and mutual savings banks, where greater returns would be received. Thus they would be a real benefit not only to the people, but also to the existing financial institutions. Practically all the leading nations, with the exception of the United States, have postal savings banks in successful operation. No one can justly say they are not needed in the United States, with its vast sections unequipped with facilities for the deposit of savings."

Rural Telephones. — The greatest boon of recent years to the farmer and to the rural districts has been the rural telephone. No longer is it necessary for the farmer to spend several days and travel several miles to secure help that he may need when he is ready to harvest or thrash his grain, since all these matters now may be arranged in a few minutes by the use of the telephone. The doctor can be called without the necessity of a long trip, and in cases of serious accident many valuable lives may be saved that otherwise would not be possible. The long distance telephone enables the farmer to call up the supply house or factory and secure small supplies or repairs without loss of time. When the self-binder or the thrasher breaks down, the loss of a few days' time may mean the loss of much valuable grain, especially when the weather is unsettled.

On many rural telephone lines the weather reports are sent out at noon and market reports are sent out at six o'clock to all those who care to receive them.

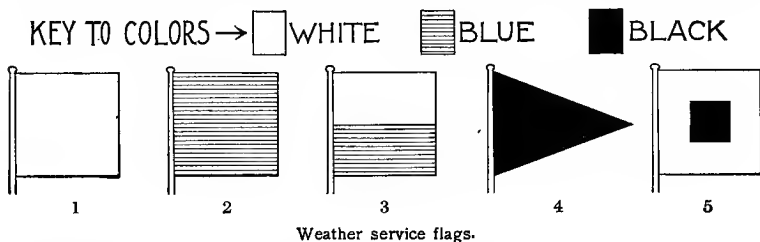
Through the use of the rural lines farmers' wives no longer feel the effect of isolation when they live long distances apart, since they can now chat with each other over the telephone and learn the latest items of news. It also enables them to arrange for social gatherings.

The Interurban Car. — Thus far the steam railroads have offered no special advantages to the farmers because the trains are not frequent enough and generally they are too far away. But the interurban trolley car has been found a very satisfactory and

convenient mode of transportation for rural residents who wish to spend a few hours in the city and return the same day or night. It also affords a chance for the rapid delivery of express and light packages of freight. Likewise it can be used to good advantage for the rapid delivery of mail between the villages and towns along the route of the interurban trolley line.

By means of the telephone the farmer can order repairs for broken machinery or other necessary articles and have them delivered frequently in the course of a few hours. If there is some lecture or entertainment in the city which he and his family wish to attend, it is a very easy matter to telephone for the tickets a day or two in advance without the necessity of having to make a trip for that purpose. Then through the services of the interurban trolley line it is possible for him and his family to visit the city in the afternoon, attend an entertainment in the evening, and return home the same night. Interurban car lines have generally been successful wherever tried, and farmers have always accorded them a liberal patronage from the very start.

The United States Weather Service. — Provision for daily weather reports was first made in 1870 in connection with the



signal service of the army; but about 1890 this feature was made a part of the work of the Department of Agriculture.

The forecasts, which are prepared daily at the central office in Washington, D.C., and certain designated stations, are telegraphed to all stations of the Weather Bureau, railway officials, postmasters, and voluntary observers generally in time to be received between ten o'clock and noon of each day. These reports are sent out by means of rural telephones, by bulletins transmitted by rural mail service, by means of signal flags of certain designs and

colors, and by steam whistles, blown sufficiently strong to be heard some distance away. The flags used for this purpose are as follows:

No. 1. White flag indicates clear and fair weather.

No. 2. Blue flag signifies rain or snow.

No. 3. White and blue flag indicate local rain or snow.

No. 4. Black triangular flag is a temperature signal.

No. 5. White with black square in the center indicates that a cold wave is expected.

When No. 4 is placed above Nos. 1, 2, or 3, warmer weather is expected; when placed below these signals, colder weather is expected; and when not displayed, stationary temperature is anticipated.

Whistle Signals. — The whistle signals are as follows:

Warning blast blown from fifteen to twenty seconds to attract attention.

One long blast for fair weather.

Two long blasts for rain or snow.

Three long blasts for local rain or snow.

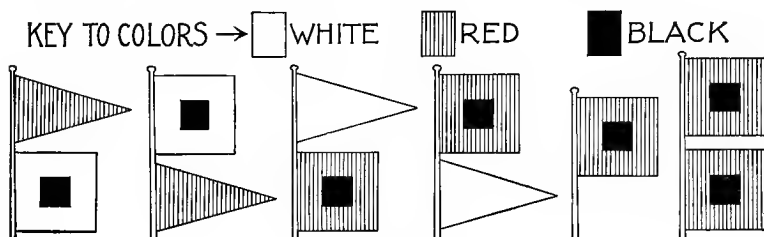
One short blast for lower temperature.

Two short blasts for higher temperature.

Three short blasts for a cold wave.

The long blasts are blown from four to six seconds, while the short blasts are blown from one to three seconds.

Wind and Storm Signals. — A red flag with a black center forecasts a storm of great force and violence. Two such flags displayed



Wind and storm signals.

one above the other indicate a tropical hurricane or a very severe, dangerous storm. A red pennant signifies that easterly winds are expected, while a white pennant indicates westerly winds. When

either of these pennants is placed above other flags, it signifies that the wind will likely blow from the northern quadrants; but when placed below, the wind is expected to come from the southern quadrants.

Local and County Institutes.—Institute lectures for farmers were inaugurated by the New York Agricultural Society as early as 1842, and ten years later Massachusetts took the initial steps



Class in home economics, Mills College.

looking to the establishment of farmers' institutes. Since then the idea has been thoroughly worked out and the movement has extended to every State.

According to Professor Bailey: "The function of the institute is to educate people on their own ground. It is a phase of extension work that carries education directly to the localities in which the people live. It deals less with individual men on their farms than with small communities or groups of men; it therefore has the opportunity to exert great influence in developing the social life of rural neighborhoods. Institute education should stimulate initiative and develop incentive in the locality and set forth the best community ideals."

The work of the institute may be accomplished (1) through popular lectures delivered by instructors from the Agricultural and Mechanical College in each State or by special agricultural experts sent out by the national government; (2) by means of object teaching and practical demonstrations; (3) by stationing special expert teachers in certain localities; (4) by offering short courses of instruction from two to four weeks in length at some central or convenient point on agricultural topics; (5) by holding a general State meeting once a year at the capital of the State or at the seat of the State Agricultural and Mechanical College.

The institute work is generally placed under the direction and control of the State Board of Agriculture or the Agricultural and Mechanical College in each State. In some cases a special organizer or conductor of farmers' institutes is employed by the State, whose duty it



Dinner table, set by class in household economics, New Mexico Agricultural and Mechanical College.

is to lecture to the farmers and organize district and county institutes. After the work is organized the coöperation of the county superintendent of schools and the practical farmers of the county should be secured. Whenever possible, arrangements should be made to have lectures given by the instructors of the Agricultural and Mechanical College. But the work should not stop with the farmers. The wives of the farmers may be reached and made to take an interest in the institute move-

ment by the formation of cooking clubs and sewing clubs. The school children can be brought into line and interested in agriculture through the organization of boys' and girls' experiment clubs. Mr. John Hamilton, Farmers' Institute Specialist of the United States Department of Agriculture, says:

"I now think that the farmers' institute movement must take hold of the country boy and the country girl. We have been dealing with the fathers and mothers thus far, which was a necessity until the value of the institute was demonstrated; but we have come now, in my opinion, to a time in which it will be possible for us, in many States, to go a step farther and take hold of the young people who are living on the farm."

There is no better way to reach the country boy and country girl than through the organization of experiment or contest clubs. The contests for the boys may include work in manual training, grain growing, gardening and stock raising; while the work for the girls may include light gardening, raising of poultry, domestic science, and sewing. The interest in this part of the work can be greatly increased by offering suitable prizes at the State and county fairs for the best exhibits made by the members of the respective contest clubs. Nebraska, Missouri, Oklahoma, Illinois, Iowa, Wisconsin, and several other States have organized boys' and girls' experiment clubs and have demonstrated beyond question their popularity and general worth.

The farmers' institute movement in some form has now extended to every State, and the general interest in the work is increasing.

QUESTIONS

1. What seems to be responsible for the tendency of our young people to migrate from the farm to the city?
2. Discuss the arrangement of the kitchen in a farm home.
3. Discuss the arrangement of the cistern and the water supply.
4. What means of illumination are at the farmers' disposal?
5. What would you recommend in the way of furniture and home furnishings?
6. Discuss the need of better schools in the country.
7. Discuss the formation of consolidated school districts and graded schools.
8. Enumerate the advantages consolidated schools have over the average school.

9. What States have taken the lead in forming consolidated school districts?
10. Discuss community improvement clubs.
11. When and where was the first rural mail route established?
12. What can you say of the growth of this service?
13. Discuss the effect of this service on farm life.
14. Explain the mode of procedure in preparing and filing a petition for this service.
15. Discuss the need of a parcels post.
16. What is said of postal savings banks?
17. Discuss rural telephones.
18. What is said concerning the interurban car and its service?
19. Discuss the United States Weather Service.
20. Give a brief history of the origin and development of the farmers' institute movement.

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APPENDIX

1. FEEDING STANDARDS

POUNDS PER DAY PER 1000 POUNDS LIVE WEIGHT

ANIMAL		DRY MATTER	PROTEIN	CARBO- HYDRATES	ETHER EXTRACT OR FAT	NUTRITIVE RATIO 1 TO x
1. Fattening Cattle		lb.	lb.	lb.	lb.	lb.
First Period		30	2.5	15.0	0.5	1 : 6.5
Second Period		30	3.0	14.5	0.7	1 : 5.4
Third Period		26	2.7	15.0	0.7	1 : 6.2
2. Growing Cattle						
Age in months	Average live weight lb. per head					
2-3	150	22.0	4.0	13.8	2.0	1 : 4.7
3-6	300	23.4	3.2	13.5	1.0	1 : 5.0
6-12	500	24.0	2.5	13.5	0.6	1 : 6.0
12-18	700	24.0	2.0	13.0	0.4	1 : 7.0
18-24	850	24.0	1.6	12.0	0.3	1 : 8.0
3. Milch Cows						
Daily yield lb. of milk						
11.0		25	1.6	10.0	0.3	1 : 6.7
16.6		27	2.0	11.0	0.4	1 : 6.0
27.5		32	3.3	13.0	0.8	1 : 4.5
4. Horses						
Light Work		20	1.5	9.5	0.4	1 : 7.0
Medium Work		24	2.0	11.0	0.6	1 : 6.2
Heavy Work		26	2.5	13.3	0.8	1 : 6.0
5. Sheep — Wool Producing						
Coarse Wool		20	1.2	10.5	0.2	1 : 9.1
Fine Wool		23	1.5	12.0	0.3	1 : 8.5
6. Sheep — Fattening						
First Period		30	3.0	15.0	0.5	1 : 5.4
Second Period		28	3.5	14.5	0.6	1 : 4.5
7. Swine — Fattening						
First Period		36	4.5	25.0	0.7	1 : 5.9
Second Period		32	4.0	24.0	0.5	1 : 6.3
Third Period		25	2.7	18.0	0.4	1 : 7.0

2. COMPOSITION OF FOOD STUFFS

NAME OF FEED	DRY MATTER PER 100 LB.	DIGESTIBLE NUTRIENTS IN 1000 LB.			FERTILIZING CONSTITU- ENTS IN 1000 LB.		
		Protein	Carbo- hydrates	Ether Extracts	Nitrogen	Phos- phoric Acid	Potash
Concentrates	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Corn	89.1	7.9	66.7	4.3	18.2	7.0	4.0
Wheat	89.5	10.2	69.2	1.7	23.6	7.9	5.0
Wheat Bran	87.7	12.3	37.1	2.6	....	....	....
Wheat Shorts	88.2	12.2	50.0	3.8	28.2	13.5	5.9
Oats	89.0	9.2	47.3	4.2	20.6	8.2	6.2
Oat Shorts	92.3	12.0	46.9	2.8	17.2	9.1	5.3
Kaffir Corn	84.8	7.8	57.1	2.7	....	....	....
Cotton-seed Meal	91.8	37.2	16.9	12.2	67.9	28.8	8.7
Soy Beans	89.2	29.6	22.3	14.4	53.0	18.7	19.0
Cowpeas	85.2	18.3	54.2	1.1	33.3	....	....
Roughage							
Fodder Corn, Green	20.7	1.0	11.6	0.4	4.1	1.5	3.3
Fodder Corn, Field	57.8	2.5	34.6	1.2	17.6	5.4	8.9
Corn Stover, Field	59.5	1.7	32.4	0.7	10.4	2.9	14.0
Kentucky Blue Grass	34.9	3.0	19.8	0.8	....	....	....
Timothy	38.4	1.2	19.1	0.6	4.8	2.6	7.6
Hay							
Kentucky Blue Grass	78.8	4.8	37.3	2.0	11.9	4.0	15.7
Red Top	91.1	4.8	46.9	1.0	11.5	3.6	10.2
Soy Bean	88.7	10.8	38.7	1.5	23.2	6.7	10.8
Timothy	86.8	2.8	43.4	1.4	12.6	5.3	9.0
Fresh Legumes							
Alfalfa	28.2	3.9	12.7	0.5	7.2	1.3	5.6
Cowpeas	16.4	1.8	8.7	0.2	2.7	1.0	3.1
Crimson Clover	19.1	2.4	9.1	0.5	4.3	1.3	4.9
Red Clover	29.2	2.9	14.8	0.7	5.3	1.3	4.0
Soy Bean	24.9	3.2	11.0	0.5	2.9	1.5	5.3
Legume Hay and Straw							
Alfalfa	91.6	11.0	39.6	1.2	21.9	5.1	16.8
Cowpeas	89.3	10.8	38.6	1.1	19.5	5.2	14.7
Crimson Clover	90.4	10.5	34.9	1.2	20.5	4.0	13.1
Red Clover	84.7	6.8	35.8	1.7	20.7	3.8	22.0
White Clover	90.3	11.5	42.2	1.5	27.5	5.2	18.1
Soy Bean	89.9	2.3	40.0	1.0	17.5	4.0	13.2
Straw							
Oat	90.8	1.2	38.6	0.8	6.2	2.0	12.4
Wheat	90.4	0.4	36.3	0.4	5.9	1.2	5.1

3. COMPOSITION OF FOOD STUFFS

ROOTS AND TUBERS

FEEDING STUFFS	WATER	CRUDE FAT	CRUDE FIBER	CRUDE PROTEIN	CRUDE ASH	CARBO- HYDRATES
Carrots	88.6	0.4	1.3	1.1	1.0	7.6
Mangels	90.9	0.2	0.9	1.4	1.1	5.5
Potatoes, Irish	79.1	0.1	0.4	2.1	0.9	17.4
Potatoes, Sweet	72.4	0.3	0.9	1.1	1.3	24.0
Red Beets	88.5	0.1	0.9	1.5	1.0	8.0
Sugar Beets	86.5	0.1	0.9	1.8	0.9	9.8
Turnips	90.5	0.2	1.2	1.1	0.8	6.2
Ruta-bagas	88.6	0.2	1.3	1.2	1.2	7.5

4. DOMESTIC WEIGHTS AND MEASURES

Apothecaries' Weight.—20 grains = 1 scruple; 3 scruples = 1 dram; 8 drams = 1 ounce; 12 ounces = 1 pound.

Avoirdupois Weight (short ton).— $27\frac{1}{2}$ grains = 1 dram; 16 drams = 1 ounce; 16 ounces = 1 pound; 25 pounds = 1 quarter; 4 quarters = 1 cwt.; 20 cwt. = 1 ton.

Avoirdupois Weight (long ton).— $27\frac{1}{2}$ grains = 1 dram; 16 drams = 1 ounce; 16 ounces = 1 pound; 112 pounds = 1 cwt.; 20 cwt. = 1 ton.

Troy Weight.—24 grains = 1 pennyweight; 20 pennyweights = 1 ounce; 12 ounces = 1 pound.

Circular Measure.—60 seconds = 1 minute; 60 minutes = 1 degree; 30 degrees = 1 sign; 12 signs = 1 circle or circumference.

Cubic Measure.—1728 cubic inches = 1 cubic foot; 27 cubic feet = 1 cubic yard.

Dry Measure.—2 pints = 1 quart; 8 quarts = 1 peck; 4 pecks = 1 bushel.

Liquid Measure.—4 gills = 1 pint; 2 pints = 1 quart; 4 quarts = 1 gallon; $31\frac{1}{2}$ gallons = 1 barrel; 2 barrels = 1 hogshead.

Long Measure.—12 inches = 1 foot; 3 feet = 1 yard; $5\frac{1}{2}$ yards = 1 rod or pole; 40 rods = 1 furlong; 8 furlongs = 1 statute mile (1760 yards or 5280 feet); 3 miles = 1 league.

Mariner's Measure.—6 feet = 1 fathom; 120 fathoms = 1 cable length; $7\frac{1}{2}$ cable lengths = 1 mile; 5280 feet = 1 statute mile; 6085 feet = 1 nautical mile.

Paper Measure.—24 sheets = 1 quire; 20 quires = 1 ream (480 sheets); 2 reams = 1 bundle; 5 bundles = 1 bale.

Square Measure.—144 square inches = 1 square foot; 9 square feet = 1 square yard; $30\frac{1}{2}$ square yards = 1 square rod or perch; 40 square rods = 1 rood; 4 roods = 1 acre; 640 acres = 1 square mile; 36 square miles (60 miles square) = 1 township.

Time Measure.—60 seconds = 1 minute; 60 minutes = 1 hour; 24 hours = 1 day; 7 days = 1 week; 365 days = 1 year; 366 days = 1 leap year.

5. MINIMUM WEIGHTS OF PRODUCE

THE following are minimum weights of certain articles of produce according to the laws of the United States:

PER BUSHEL	PER BUSHEL	PER BUSHEL
Wheat 60 lb.	White Potatoes 60 lb.	Hungarian Grass
Corn, in the ear . 70 lb.	Sweet Potatoes 55 lb.	Seed 50 lb.
Corn, shelled . . 56 lb.	Onions 57 lb.	Timothy Seed . 45 lb.
Rye 56 lb.	Turnips 55 lb.	Blue Grass Seed 44 lb.
Buckwheat . . . 48 lb.	Dried Peaches . 33 lb.	Hemp Seed. . . 44 lb.
Barley 48 lb.	Dried Apples . . 26 lb.	Corn Meal . . . 48 lb.
Oats 32 lb.	Clover Seed . . . 60 lb.	Ground Peas . . 24 lb.
Peas 60 lb.	Flax Seed 56 lb.	Malt 34 lb.
White Beans . . . 60 lb.	Millet Seed . . . 50 lb.	Bran 20 lb.
Castor Beans . . 46 lb.		

6. SEED-PLANTING IN THE UNITED STATES

(Compiled from reports of the Department of Agriculture)

NEW ENGLAND

KIND OF CROP	DATE OF PLANTING	BEST SOIL	AMOUNT OF MANURE PER ACRE	AMOUNT OF SEED PER ACRE	WEEKS TO MA- TURITY
Corn	May 10 to 30	Sandy or clay loam	8 to 12 tons	8 to 12 qt.	14-17
Wheat	Fall or Spring	Clay loam	18 tons	2 bush.	20
Oats	April to May	Strong loam	6 to 8 tons	2 to 3 bush.	11-15
Barley	April to June	Strong loam	7 to 8 tons	2 to 3 bush.	10-15
Rye	April to May, Sept.	Medium loam	7 to 8 tons	5 to 6 pecks	40
Buckwheat	June 1 to 20	Light loam	4 to 6 tons	1 to 1½ bush.	10-15
White beans	May to June	Sandy loam	7 to 8 tons	8 to 16 qt.	8-14
Potatoes	April 15 to May 1	Rich loam	15 to 20 tons	8 to 20 bush.	12-20
Turnips	July 1 to Aug. 3	Sandy loam	10 tons	1 lb.	10
Mangels	April 15 to May 5	Strong, heavy loam	8 to 15 tons	4 to 6 lb.	17-22
Tobacco	Seed bed, April	Sandy loam	8 to 12 tons	.....	9-12
Hay	.....	.....	.....	.....	.....

MIDDLE STATES

Corn	April 20 to May 30	Medium loam	8 to 12 tons manure	6 to 8 qt.	16-18
Wheat	Sept. 20 to Oct. 20	Loam	8 tons; 300 lb. fer.	2 bush.	41-43
Oats	March to May	Moist clay loam	8 tons; 300 lb. fer.	2 to 2½ bush.	16-17
Barley	March to May	Clay loam	8 tons; 300 lb. fer.	2 to 2½ bush.	13-16
Rye	Sept. 1 to Oct. 1	Sand or gravel loam	8 tons; 300 lb. fer.	1½ bush.	40-43
Buckwheat	June to July	Loam	5 tons	½ to 1½ bush.	8-10
White beans	May to June	Sandy loam	8 tons	1½ bush.	13-14
Potatoes	March to May	Loam	10 to 18 tons	8 to 15 bush.	14-22
Sweet potatoes	May to June	Sandy loam	.....	10 to 12 bush.	10-15
Cabbage	March to July	Clay or sandy loam	300 to 600 lb. fer.	4 to 8 oz.	8-15
Turnips	July	Loam	.....	2 to 5 lb.	10-12
Mangels	May	Loam	10 to 20 tons	10 to 15 bush.	15-18
Flax	May	Limestone loam	.....	20 qt.	8-10
Tobacco	Seed bed, March	Sandy loam	Commercial fer.	.....	15-20
Hay, timothy	Aug. to Oct.	Clay loam	.....	6 to 8 qt.	.....
Hay, clover	Feb. to April	Clay loam	.....	6 qt.	.....

TABLE 6—continued
CENTRAL AND WESTERN STATES

KIND OF CROP	DATE OF PLANTING	BEST SOIL	AMOUNT OF MANURE PER ACRE	AMOUNT OF SEED PER ACRE	WEEKS TO MA- TURITY
Corn	April 1 to June	Black or sandy loam	5 to 10 tons	6 qt.	16-20
Wheat	Fall or Spring	Strong loam	8 tons	2 bush.	40-42
Oats	April 1 to May	Clay loam	8 tons	2 to 3 bush.	12-14
Barley	Fall or Spring	Clay loam	8 tons	2 bush.	11-13
Rye	Sept. 1 to 30	Light loam	8 tons	1 to 2 bush.	35-40
Buckwheat	June	Clay loam	5 tons	1 to 2 bush.	1-12
White beans	May 10 to June 10	Clay loam	8 tons	1½ bush.	12
Potatoes	March 15 to June 1	Sandy loam	5 to 10 tons	5 to 10 bush.	10-20
Turnips	July 15 to Aug. 30	Loam or muck	8 to 10 tons	1 to 6 lb.	10-16
Mangels	April 1 to May 15	Sandy loam	8 to 12 tons	6 to 8 lb.	22-24
Flax	March 15 to May 15	Loam	10 to 15 tons	2 to 3 pecks	15-20
Tobacco	Seed bed, March	Sandy loam	8 to 10 tons	oz. to 6 sq. rd.	15-18
Hay	April to May	Clay loam	10 tons	8 to 15 lb.	.....

SOUTHERN STATES

KIND OF CROP	DATE OF PLANTING	BEST SOIL	AMOUNT OF MANURE PER ACRE	AMOUNT OF SEED PER ACRE	WEEKS TO MA- TURITY
Cotton	Feb. to May 15	Sandy loam	.....	1 to 3 bush.	20-30
Corn	Feb. to June	Rich loam	10 bush. cot. seed	8 qt.	18-20
Wheat	Sept. to Nov.	Clay loam	8 tons	2 bush.	43
Oats	Feb., May, Sept.	Clay loam	8 to 10 tons	2½ bush.	17
Barley	Apr. to May	Clay loam	8 to 10 tons	2½ bush.	17
Rye	Sept. to Oct.	Clay loam	10 tons	1½ bush.	43
White beans	March to May	Light loam	8 tons	1 to 2 bush.	7-8
Cabbage	Oct., March to May	Light loam	6 to 10 tons	1 to 2 lb.	14
Watermelons	March 1 to May 10	Rich, light loam	5 tons; 300 lb. fer.	2 to 7 lb.	16-20
Onions	Feb. 1 to April 10	Loam or muck	.....	.....	16-24
Potatoes	Jan., Feb. to April	Light, loose loam	8 to 12 tons	8 to 10 bush.	11-15
Sweet potatoes	May to June	Sandy loam	.....	10 to 12 bush.	12-15
Pumpkins	April 1 to May 1	Rich, light loam	.....	4 to 7 lb.	17-20
Tomatoes	Jan. 1 to Feb. 19	Rich, sandy loam	.....	4 to 9 oz.	14-20
Turnips	Feb., Aug., April	Rich, light loam	.....	2 to 6 lb.	8-12
Tobacco	Seed bed, March	Sandy loam	8 to 15 tons	oz. to 6 sq. rd.	18-20
Cowpeas	May 1 to July 15	Sandy loam	200 to 300 lb. phos.	2 to 5 pecks	6-8

7. RULES AND SCORE CARD FOR CORN JUDGING IN OKLAHOMA

AGRICULTURAL AND MECHANICAL COLLEGE, STILLWATER

Uniformity. — The ears in an exhibit should be similar in size, shape, color, and indentation. For each ear deficient in these respects cut the exhibit one point.

Shape of Ears. — The ears should conform to variety type, usually cylindrical, tapering slowly from butt to tip. Cut each ear one point that does not meet requirements.

Color of Cob. — Should be uniformly red for yellow corn and usually uniformly white for white corn. For each white cob in an exhibit of yellow corn cut exhibit one half point. Do same for each red cob in an exhibit of white corn, unless variety type has red cob; then cut for white cobs. For other colors of corn cut one half point for each cob that is off from predominating color.

Color of Kernels. — For each white-crowned kernel in a red or yellow variety, cut one tenth point. For each yellow-cast kernel beneath the crown in white corn cut one tenth point.

Market Condition. — Ripe, sound, bright ears, firm and well matured. For each ear deficient in these respects cut the exhibit one point.

Tips of Ears. — Not too tapering; well filled with regular, uniform kernels. Add together the length of protruding cobs on tips of all ears in exhibit and cut at the rate of one half point for each inch.

Butts of Ears. — Rows of kernels should extend in regular order over the butts. Cut the exhibit one half point for each poorly and irregularly filled butt, and one fourth point for each flat butt.

Kernel Uniformity. — Uniform in shape and size and conforming to variety type. Remove two kernels from adjoining rows near the middle of each ear, and place before the ear with germ side up. Cut the exhibit one point for each ear failing in above points, shown by pairs of kernels.

Kernel Shape. — Should be medium wedge shape, straight edge, large germ. Use pairs of kernels removed for scoring last point (uniformity). Cut each ear one point for failing in above points, shown by pairs of kernels.

Space. — Furrow between rows small, not over one thirty-second of an inch at any point on ear. Cut one fourth point for space between one thirty-second and one sixteenth of an inch; and one half point for space greater than one sixteenth of an inch.

Proportion of Corn on Ear. — Is determined by weight; should not be less than 85 per cent. For every per cent below that cut exhibit one point, and for every per cent above add one point. To get the per cent, weigh ear, shell corn, weigh shelled corn, divide weight of shelled corn by weight of ear.

Weight of Grain. — Get the average length of ears in exhibit; use the weight of grain found in last point. For each ounce below number required by ears of given length, cut the exhibit one point, and for each ounce above, add one point.

SCORE CARD FOR CORN JUDGING
(A. and M. College, Stillwater, Okla.)

Variety Name.....

	VALUE	SAMPLE No.		SAMPLE No.	
		Student Score	Corrected Score	Student Score	Corrected Score
Uniformity of exhibit	10	.....	.....	.....	.....
Shape of ears.....	10	.....	.....	.....	.....
Color of cob	5	.....	.....	.....	.....
Color of kernels	5	.....	.....	.....	.....
Market condition.....	10	.....	.....	.....	.....
Tips of ears	5	.....	.....	.....	.....
Butts of ears	5	.....	.....	.....	.....
Uniformity of kernels	10	.....	.....	.....	.....
Shape of kernels	10	.....	.....	.....	.....
Space between kernels	5	.....	.....	.....	.....
Proportion of corn on ear .	15	.....	.....	.....	.....
Weight of grain	10	.....	.....	.....	.....
Total	100	.....	.....	.....	.....

8. OUTLINE FOR SCORING DENT CORN

MICHIGAN AGRICULTURAL COLLEGE

	THINGS TO CONSIDER	RULE FOR CUTS
1 (a)	Nearness of approach to type as to general form of kernel, indentation, etc.	$\frac{1}{2}$ point off for each variation from type.
(b)	Likeness between ears exhibited.	$\frac{1}{2}$ point off for each odd ear.
2	Shape of ear. Arrangement and character of rows.	$\frac{1}{2}$ point off for each poorly shaped ear.
3	Freedom from cross breeding Trueness to variety color of kernel and cob.	10 points off for $\left\{ \begin{array}{l} \text{red cob in} \\ \text{white ear or} \\ \text{white cob in} \\ \text{yellow ear.} \end{array} \right.$ $\frac{1}{10}$ point off for each mixed kernel. ³
4	¹ Ripeness, soundness, freedom from injury, brightness of color and vitality.	1 point off for every diseased, injured, chaffy, or immature ear.
5	Uniformity of kernels, regularity of rows, completeness of covering. ²	$\frac{1}{4}$ point off for every badly covered tip. $\frac{1}{2}$ point off for every inch of exposed tip. $\frac{1}{8}$ point off for every $\frac{1}{8}$ inch exposed tip.
6	Manner of rounding out and quality of kernels.	$\frac{1}{2}$ point off for every uncovered butt. $\frac{3}{10}$ point off when butt is covered but kernels are flat.
7 (a)	Likeness in shape and conformity to type.	$\frac{1}{2}$ point for each set of kernels lacking in general uniformity.
(b)	Approach to ideal wedge shape.	$\frac{1}{2}$ point off for each set of poorly shaped kernels.
8	Variation from standard length.	1 point off for every inch of excess or deficiency in length of ear.

¹ Indicated by firmness of kernel on cob. ² Does not have reference to length of cob.

³ Kernels missing count as mixed kernels.

	THINGS TO CONSIDER	RULE FOR CUTS
9	Variation from standard circumference.	1 point off for every 2 inches of excess or deficiency in circumference of ear.
10 (a)	Outer space.	No cut for less than $\frac{1}{32}$ inch between rows. $\frac{1}{4}$ point off for $\frac{1}{32}$ to $\frac{1}{16}$ inch between rows. $\frac{1}{2}$ point off for $\frac{1}{16}$ inch between rows.
(b)	Inner space.	$\frac{1}{4}$ to $\frac{1}{2}$ point off for each marked case of space between near points of rows.
11	Per cent of grain to ear.	1 point off for each per cent short in weight of corn.

For Dent Corn ears should have length of 9 inches, circumference of 7 inches, and shell 88 per cent grain.

9. SCORE CARD FOR CORN IN NEBRASKA

Variety Name..... Number of Exhibit.....

	VALUE	STUDENT'S SCORE	CORRECTED SCORE
Uniformity of exhibit	10	.....	.....
Shape of ears	10	.....	.....
Color of cob	5	.....	.....
Color of kernels	5	.....	.....
Market condition	10	.....	.....
Tips of ears	5	.....	.....
Butts of ears	5	.....	.....
Uniformity of kernels	10	.....	.....
Shape of kernels	10	.....	.....
Space between kernels	5	.....	.....
Proportion of corn on ear	10	.....	.....
Weight of grain	15	.....	.....

Student's Name.....

Date.....

10. SCORE CARD FOR JUDGING SEA ISLAND AND UPLAND COTTON

(U. S. Bureau of Plant Industry)

Size of bolls, 15 points	{ Very large, 15 points. Large, 14 points. Medium, 12 points. Small, 8 points. Very small, 3 points.
Length of lint, 20 points	{ 2 inches, 20 points. $1\frac{7}{8}$ in., 19 points. $1\frac{3}{4}$ in., 18 points. $1\frac{5}{8}$ in., 17 points. $1\frac{1}{2}$ in., 15 points. $1\frac{3}{8}$ in., 10 points. $1\frac{1}{4}$ in., 5 points.
Fineness of lint, 10 points	{ Very fine, 10 points. Fine, 8 points. Medium, 6 points. Coarse, 3 points.
Yield, 20 points	{ Excellent, 20 points. Good, 18 points. Medium, 15 points. Light medium, 10 points. Light, 5 points.
Uniformity in length, 7 points	{ Excellent, 7 points. Good, 6 points. Fair, 4 points. Poor, 2 points.
Strength of lint, 10 points	{ Very strong, 10 points. Strong, 8 points. Medium, 8 points. Weak, 3 points
Per cent of lint, 18 points	{ 33 per cent, 18 points. 31-32 per cent, 17 points. 29-30 per cent, 16 points. 27-28 per cent, 15 points. 25-26 per cent, 10 points. 23-24 per cent, 5 points.

11. LIST OF CENTRAL STATIONS OF UNITED STATES WEATHER BUREAU

Alabama, Montgomery.	Massachusetts, Boston	Oklahoma, Oklahoma.
Arizona, Phœnix.	(for New England).	Oregon, Portland.
Arkansas, Little Rock.	Michigan, Grand Rapids.	Pennsylvania, Philadel-
California, San Francisco.	Minnesota, Minneapolis.	phia.
Colorado, Denver.	Mississippi, Vicksburg.	South Carolina, Colum-
Florida, Jacksonville.	Missouri, Columbia.	bia.
Georgia, Atlanta.	Montana, Helena.	South Dakota, Huron.
Idaho, Boise.	Nebraska, Lincoln.	Tennessee, Nashville.
Illinois, Springfield.	Nevada, Reno.	Texas, Galveston.
Indiana, Indianapolis.	New Jersey, Atlantic	Utah, Salt Lake City.
Iowa, Des Moines.	City.	Virginia, Richmond.
Kansas, Topeka.	New Mexico, Santa Fé.	Washington, Seattle.
Kentucky, Louisville.	New York, Ithaca.	West Virginia, Parkers-
Louisiana, New Orleans.	North Carolina, Raleigh.	burg.
Maryland, Baltimore	North Dakota, Bis-	Wisconsin, Milwaukee.
(for Delaware and	marck.	Wyoming, Cheyenne.
Maryland).	Ohio, Columbus.	

SIMPLE EXPERIMENTS

A great many teachers imagine that instruction in agriculture cannot be given without a large laboratory and expensive equipment, but this is far from the truth.

Much of the material needed is inexpensive, and many of the exercises are so simple that even the untrained teacher in the one-room rural school need have no hesitation in undertaking such work. The materials absolutely essential are as follows: two dozen tomato cans, half a dozen lard pails, a few baking-powder cans, a number of empty bottles, a few cigar boxes, a collection of typical soils, — such as common clay, sand, and loam, — and a few farm and garden crop seeds. Many other things of this kind may be added to our equipment at little or no cost. To this we may add by purchase an 8-ounce graduate, costing 10 cents; four dairy thermometers at 60 cents; six student's lamp chimneys, 30 cents; 100 5-inch filter papers, 15 cents; a pint glass funnel, 15 cents; a 4-bottle Babcock milk tester, with test bottles, pipette acid measure, and acid for tests, \$5; an alcohol lamp, 25 cents; a kitchen scale with dial which will register from one ounce to twenty-four pounds, 90 cents; twelve ordinary glass tumblers, 50 cents; one dozen Mason fruit jars, \$1; a small quantity of litmus paper; a few ordinary China plates; pie tins; ten yards cheese cloth; a few lamp wicks; a few pieces of window glass — and our outfit is practically complete, and all at a cost slightly exceeding \$10.

Superintendent Guy M. Lisk of Alva, Oklahoma, offers a valuable agriculture cabinet for \$25 which contains sufficient apparatus for all ordinary purposes.

With such an equipment we are prepared to determine the comparative temperature, weight, acidity, alkalinity, porosity, capillarity, and fertility of different soils; to test their water-holding capacity and readiness with which they may be drained, and to show the effect of cultivation, mulching, and puddling on the moisture content and physical condition of different soils. Much of your work may be of such a practical character that it would be of immediate benefit to the agriculture of the community, such as testing seeds for vitality; milk and cream for butter fat; treating oats and wheat for smut, and potatoes for scab; spraying plants for insect pests; making plans for farm buildings, roads, walks, etc. Such work could be done largely by the pupils at school or on different farms on Saturdays, if no other time was convenient for the purpose. This would be educational and at the same time would make the farmers feel that they were getting some immediate tangible return on the taxes paid for the support of the school.

Then, aside from its practical value, agriculture may be made an aid to other school work in many ways. Mathematics will be applied in the use of weights and measures, while the principles of percentage and proportion will enter into the solution of nearly every problem in soils. Composition will lose some of its bad flavor and spelling will no longer be distasteful

when applied to the description of experiments in which the pupils are interested. Manual training will find expression in the making of boxes, labels, farm levels, and many other appliances used in the various experiments. Some of the principles of Botany, Physics, and Chemistry will be learned and applied in our study with soils, plants, and milk. When handled in this way, all of the work will leave a more lasting impression, because it is concrete, and at the same time it will be more interesting because it is connected with the life and occupation of the pupils.

— *Excerpt from article by J. W. Wilkinson.*

On account of the differences in climate, soil, and the kinds of crops raised in the various parts of our country, it is difficult to offer a set of laboratory experiments in agriculture that will be specially adapted to the needs of each locality. The teacher will find it best to consult a number of laboratory manuals in agriculture and then select such work as will best suit the needs of his pupils. Any experiment that helps to fix a principle in the mind and that is brief and interesting should be introduced.

A great deal of field work should be introduced and made the foundation for this work. The school garden, the improvement of the school yard, and school excursions may be made interesting and instructive features of instruction in agriculture when properly managed.

Useful suggestions for laboratory exercises will be found in the following manuals:

One Hundred Lessons in Elementary Agriculture, Nolan, Acme Pub. Co., Morgantown, West Virginia.

Rural School Agriculture, Davis, Orange Judd Co.

Dairy Laboratory Guide, Melick, D. Van Nostrand Co., N.Y.

Soil Physics Laboratory Guide, Stevenson & Schaub, Orange Judd Co.

Manual of Corn Judging, Shamel, Orange Judd Co.

One Hundred Experiments in Agriculture, Riley O. Johnson, Chico, California.

Illustrative Material for Agriculture, D. J. Crosby, U. S. Dept. Agriculture.

Physical Properties of Soils, McCall, Orange Judd Co.

AGRICULTURAL EXPERIMENT STATIONS

- Alabama — College Station, Auburn. Canebrake Station, Uniontown.
Tuskegee Station, Tuskegee.
- Alaska — Sitka.
- Arizona — Tucson.
- Arkansas — Fayetteville.
- California — Berkeley.
- Colorado — Fort Collins.
- Connecticut — State Station, New Haven Storrs Station, Storrs.
- Delaware — Newark.
- Florida — Gainesville.
- Georgia — Experiment.
- Hawaii — Federal Station, Honolulu.
- Idaho — Moscow.
- Illinois — Urbana.
- Indiana — Lafayette.
- Iowa — Ames.
- Kansas — Manhattan.
- Kentucky — Lexington.
- Louisiana — State Station, Baton Rouge. Sugar Station, Audubon
Park. North Louisiana Station, Calhoun.
- Maine — Orono.
- Maryland — College Park.
- Massachusetts — Amherst.
- Michigan — East Lansing.
- Minnesota — St. Anthony Park, St. Paul.
- Mississippi — Agricultural College.
- Missouri — College Station, Columbia. Fruit Station, Mountain Grove.
- Montana — Bozeman.
- Nebraska — Lincoln.
- Nevada — Reno.
- New Hampshire — Durham.
- New Jersey — New Brunswick.
- New Mexico — Agricultural College.
- New York — State Station, Geneva. Cornell Station, Ithaca.
- North Dakota — Agricultural College.
- North Carolina — West Raleigh.
- Ohio — Experiment Station, Wooster. College Station, Columbus.
- Oklahoma — Stillwater.
- Oregon — Corvallis.

Pennsylvania — State College.
Philippine Islands — Federal Station, Manila.
Porto Rico — Mayaguez.
Rhode Island — Kingston.
South Carolina — Clemson College.
South Dakota — Brookings.
Tennessee — Knoxville.
Texas — College Station.
Utah — Logan.
Vermont — Burlington.
Virginia — Blacksburg.
Washington — Pullman.
West Virginia — Morgantown.
Wisconsin — Madison.
Wyoming — Laramie.

UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, D.C.

Special Divisions

Bureau of Animal Industry.	Bureau of Statistics.
Bureau of Plant Industry.	Division of Publications.
Bureau of Entomology.	Forest Service.
Bureau of Biological Survey.	Office of Experiment Stations.
Bureau of Chemistry.	Office of Public Roads.
Bureau of Soils.	Weather Bureau.

SUGGESTED LIST OF AGRICULTURAL APPARATUS AND SUPPLIES

	LIST	NET
	\$	\$
6 Tumblers	.30	
1 Glass Rod, 8 × ¼"	.05	
1 lb Nitric Acid and GSB (glass stopper bottle)	.30	
1 lb Charcoal Lumps	.11	
6 W. M. Bottles, 16 oz.	.45	
1 lb Cotton Batting	.33	
1 Glass Tray	.20	
6 Lightning Jars, 1 pt.	.75	
6 Candles, 12's	.11	
3 ft. Rubber Tubing, ¼"	.36	
1 lb Marble Chips	.11	
1 lb Hydrochloric Acid and GSB	.27	
2 lb Copper Sulphate	.27	
3 Crystallizing Dishes, 4"	.75	
6 Argand Lamp Chimneys	.38	
1 Bladder	.16	
1 lb Granulated Zinc	.18	
1 pt. Alcohol and bottle	.60	
¼ lb Camphor Gum	.55	
1 Balance	3.10	
1 Set Weights, 1 lb down	1.10	
1 Germinating Box	.55	
2 lb Mercury and bottle	2.00	
½ lb Glass Tubing, ¼"	.22	
1 Graduate, 8 oz., 250 cc.	.65	
1 Book Red Litmus Paper	.06	
1 Book Blue Litmus Paper	.06	
1 Pasteurizing Apparatus (heavy tin, with handles and covers, rack holds and graduated bottles and brush for cleaning)	2.75	
(2 Milk Tester Bottle Machines, with 2 cream test bottles and combination pipette)	5.00	

	LIST	NET
	\$	\$
(4 Milk Tester Bottle Machines, complete, for testing cream and milk, including two test cream bottles and combined pipettes) . . .	6.60	
(6 Milk Tester Bottle Machines, inclosed with full set of glassware, including test bottle pipette, acid measure, test bottle brush, and bottle of acid)	10.00	
1 Measuring Pipette, 17.6 × 18 cc.	.22	
1 Milk Test Bottle	.22	
1 Cream Test Bottle, 30%	.33	
1 Cream Test Bottle, 40%	.39	
1 Cream Test Bottle, 50%	.44	
1 Cream Test Bottle, 9" long, grad. to 55% by $\frac{1}{2}\%$ division	.50	
1 Acid Measure, 17.5 cc	.17	
1 Dairy Thermometer	.33	
12 Milk Bottles, 1 pt.	.66	
1 Jar, Glass, 4 × 5"	.20	
1 Petri Dish	.25	
1 Cyanide Bottle	.17	
1 Earth Thermometer	1.25	
1 lb Charcoal Powder	.11	
6 Flower Pots, with saucers, 6"	1.10	
$\frac{1}{2}$ gal. Ammonia and bottle	.77	
25 lb Acid Phosphate	1.10	
5 lb Bone Meal	.44	
25 lb Rock Phosphate	.55	
5 lb Muriate of Potash	.66	
10 lb Kainite	.55	
5 lb Sulphate of Potash	.66	
25 lb Dried Blood	2.00	
5 lb Gypsum	.27	
5 lb Guano	.66	
1 Ruler	.04	
1 Tape Line, 10 m.	.75	
12 Paper Bags	.16	
1 pkg. Paper Tags	.11	
1 Ball Twine	.11	
1 Knife	.22	
5 lb Formaldehyde and bottle	1.65	
1 Knife, budding and propagating	2.00	

	LIST	NET
1 lb Grafting Wax, prepared	\$.55	\$
1 Insect Net	1.10	
1 Pruning Saw, double edge, 18"	1.25	
1 Pruning Scissors	.80	
12 Sheets Cork, for insect box	1.10	
1000 Insect Pins	1.00	
1 lb Paris Green, dry	.45	
4 lb Copper Sulphate, dry	.55	
1 lb Bordeaux Mixture, dry	.40	
1 lb Whale Oil Soap	.27	
1 lb Sulphur Flour	.11	
1 Bucket Pump, with lever handle and Bordeaux nozzle for spraying	6.60	
Score Cards (per block of 50 on the following sub- jects sold only in blocks), per block	.55	
Cattle, Beef.		
Cattle, Dairy.		
Corn.		
Cotton.		
Fruit.		
Hogs, Breeding.		
Horse, Draft.		
Horses, Light.		
Market Cream.		
Oats.		
Sheep.		
Wheat.		
6 Test-tubes, $6 \times \frac{3}{4}$ "	.15	
1 Test-tube Support	.27	
1 Rubber Stopper, 2-holed, to fit 4541 4 oz.	.11	
1 Test-tube Clamp	.10	
1 Test-tube Brush	.05	
2 Dissecting Needles	.14	
1 Forceps	.11	
1 Ring Stand, 2 rings	.50	
1 Glass Funnel, 5"	.21	
1 Student's Dissecting Microscope	1.50	
1 Alcohol Lamp, 4 oz.	.27	
1 pkg. Filter Paper, 5" 12.5 cm.	.15	
1 Ea. Reagent Bottles, # 2 4, 15	.50	
1 Microscope		29.25

	LIST	NET
	\$	\$
72 Slides	.50	
$\frac{1}{2}$ -oz. Cover Glasses, # 2, round, $\frac{3}{4}$ "	.45	
1 Soil Auger, 2"	6.60	
1 Canvas Bag, to hold samples of soil	.22	
1 piece White Oil Cloth, 18 $\times$ 18"	.20	
1 Evap. Dish, 3"	.13	
1 Drying Oven, 10 $\times$ 12, single wall	8.50	
6 Soil Pans, zinc, $4\frac{1}{4}$ $\times$ $3\frac{1}{4}$ $1\frac{1}{2}$ "	1.20	
1 Harvard Trip Scale (recommended)		5.25
1 Set Weights, 1 kilo to 5 grams	1.20	
6 Jars, 1 qt.	.85	
1 Crucible, porc., # 00	.16	
1 Desiccator, 4"	.60	
1 Thermometer	.45	
Earth Boxes, zinc, 4 $\times$ 4 $\times$ 8", inclosed in wooden box for determining the absorptive properties of different soils	2.00	
Soil Tubes, galvanized iron, 12 $\times$ 2", solid bottom	.50	
(Soil Tubes, brass, 12 $\times$ 2", solid bottom)	1.50	
Soil Tube, galvanized iron, 12 $\times$ 2", perforated bottom, 1" from end tube	.60	
(Soil Tube, brass, 12 $\times$ 2", perforated bottom, 1" from end of tube)	1.50	
Soil Tubes, 12 $\times$ 2", for percolation experiment, with two lateral inlets and one drain pipe of galvanized iron	1.10	
(Soil Tubes, same as above of brass)	2.25	
12 Tubes, to test the capillary rise of water in different soils, 60 $\times$ 1"	5.24	
2 yd. Cheese Cloth	.16	
3 Glass Tubes, 24 $\times$ 2, to test effect of vegetable water upon the capillarity of soils	1.65	
1 Wooden Rolling Pin	.25	
1 Centrifuge and Tubes	10.00	
1 Sieve, wooden frame, brass gauze, 5" diam., set of 6, 10 to 100 mesh	3.30	
1 Beaker, 350 cc.	.21	
1 Water Bath, 4"	1.50	
12 Milk Bottles, 1 qt.	.77	

GLOSSARY

Abdomen, the part of an insect behind the thorax.

Acid, a sour substance that turns blue litmus paper red.

Alkali, a caustic substance that turns red litmus paper blue.

Annual, a plant that makes its growth, matures its seed, and dies within a year.

Anther, the little sac at the end of the stamen bearing the pollen.

Available food, food that can be used by the plant.

Bacteria, the simplest and smallest forms of plant life. They may be spherical, elongated, or rodlike in form.

Balanced ration, food consisting of the proper amounts of carbohydrates, fats, and proteids.

Biennial, a plant which matures its seed and dies the second year.

Blight, a disease which causes all or a part of a plant to wither and die.

Bluestone, copper sulphate.

Bordeaux Mixture, a spray consisting of bluestone, lime, and water.

Bud, a small branch in an undeveloped state.

Budding Stick, a young shoot of one season's growth.

Calyx, the flower's outer row of leaflike forms; the outer envelope.

Calcareous, containing lime.

Cambium, the thin-walled formative tissue between the bark and the wood.

Carbohydrates, foods free from nitrogen, as sugar, starch, and cellulose.

Chlorophyll, a green granular substance found in the stems and leaves of plants.

Cohesion, attraction between particles of the same substance.

Compost, a fertilizing mixture.

Concentrates, rich feeding materials such as grains and oil cake.

Cross, the result of breeding two varieties of plants or animals together.

Dormant, sleeping or inactive.

Disintegration, crumbling to pieces.

Element, a simple substance such as iron or silver.

Ensilage, green feed preserved in an air-tight pit or silo.

Entomology, the science which treats of the life and habits of insects.

Evaporate, to pass off in the air in the form of vapor.

Filter, to clarify a liquid by passing it through cloth, paper, sand, charcoal, etc.

Filter Paper, porous unsized paper used for filtering.

Fungicide, a preparation which checks or kills fungi.

Fungus, a flowerless plant lacking chlorophyll, as molds and mushrooms.

Germinate, to sprout.

Germ, that from which any life springs.

Glacier, a vast moving body of ice.

Graft, a branch of one plant inserted in the stem of another plant so that it will unite with it and grow.

Green Manuring, growing crops plowed under for fertilizing purposes.

Gypsum, land plaster consisting of calcium sulphate.

Host, the plant on which a parasite lives.

Humus, decayed animal or vegetable matter.

Hybrid, the result of breeding two different species of animals or two different species of plants together.

Inoculate, to communicate bacteria germs by introducing matter containing a supply of them.

Insecticide, a preparation for destroying insects.

Irrigation, an artificial system of canals and ditches for supplying water to cultivated lands.

Kainit, a compound substance generally consisting of sulphate of potash, sulphate of magnesia, and chloride of magnesia. Sometimes the analysis shows sulphate of magnesia and chloride of potassium (Storer's *Agriculture*, Vol. II, p. 493).

Kerosene Emulsion, a spray consisting of kerosene oil, water, and soap.

Lactic Acid, acid derived from milk sugar.

Larva, the immature form or grub of insects.

Lichens, low mosslike and flowerless plants that grow on rocks and wood.

Loam, a soil containing sand, clay, and vegetable matter.

Marl, a mixture containing carbonate of lime, siliceous sand, and clay in varying proportions.

Mildew, a cobweblike growth of fungi on decaying matter.

Mold, a white furry growth found on damp bread, preserved fruits, manure heaps, etc.

Muck, decayed vegetable matter.

Mulch, a light cover of leaves, straw, or some other substance spread on the ground to preserve the moisture and to protect the roots of the plant.

Nitrate, a soluble compound containing a readily usable form of nitrogen.

Nodule, a little knot of rounded mass formed by certain bacteria on roots of leguminous plants.

Noxious, injurious or poisonous.

Nutrient, any substance that promotes growth in plants and animals.

Organic Matter, substances formed in the growth of plants and animals.

Osmosis, the mixing of liquids of different densities through cell walls or membranes.

Ovary, the lower part of the pistil that bears the young seed.

Oxidation, combining with oxygen to form an oxide.

Parasite, any living form that derives its nourishment by preying upon some living plant or animal.

Perennial, living from year to year.

Petal, a single leaf of the corolla or the inner colored envelope of the flower.

Pistil, the seed-bearing organ of the flower.

Pollen, the dustlike substance of the stamens which fertilizes the ovules or seeds.

Pollination, the transference of the pollen from the stamens to the pistils.

Propagate, to cause plants or animals to increase their kind.

- Proteid**, the constituent of food that contains nitrogen.
- Protein**, the total amount of nitrogenous material calculated by multiplying the nitrogen by 6.25, since proteids contain about 16% of nitrogen.
- Pruning**, trimming the branches of trees or plants for a specific purpose.
- Ration**, a fixed daily allowance of food.
- Rotation**, a certain round or succession of crops.
- Roughage**, coarse feed, such as hay, straw, or cornstalks.
- Scion**, a shoot of one season's growth used in grafting or budding.
- Sepal**, one of the leaves in the calyx or outer envelope of the flower.
- Silage**, green food preserved in a silo, or other air-tight house.
- Siliceous**, containing silica.
- Sire**, father.
- Spores**, reproductive parts of fungi that correspond to the seed in flowering plants.
- Sport**, a plant or animal in which there is a marked variation from the original type.
- Stamen**, the part of the flower which bears the anthers and pollen.
- Sterilize**, to destroy germs by heat or chemicals.
- Stock**, a seedling tree used in budding or grafting.
- Stover**, dried cornstalks from which the grain has been taken.
- Subsoil**, the portion of the ground under the top soil.
- Taproot**, the main root of the plant.
- Thorax**, the portion of an insect's body between the head and abdomen.
- Tillage**, the preparing of the land for crops.
- Transplanting**, taking up plants and resetting them.
- Tubercle**, a small knot or wartlike growth on the roots of leguminous plants.
- Udder**, the milk organs of a cow.
- Unicellular**, consisting of a single cell.
- Ventilate**, to give free access for the air.
- Virgin Soil**, land that has not been cultivated at any time.
- Vitality**, ability to germinate and grow.
- Volatilize**, to pass off in the form of vapor.
- Water Table**, the level of standing water in the ground.
- Withers**, the high point above the shoulders of a horse or mule.
- Yeast**, a collection of single-celled plants whose growth changes sugar to alcohol and carbon. It is the agent which causes bread to rise.

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